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PART II. (NATURAL HISTORY, &c.)

(NOS. I TO III.—1879: with 17 plates.)

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THE GENERAL SECRETARY.

"It will flourish, if naturalists, chemists, antiquaries, philologers, and men of science in different parts of *Asia*, will commit their observations to writing, and send them to the Asiatic Society at Calcutta. It will languish, if such communications shall be long intermitted; and it will die away, if they shall entirely cease." SIR WM. JONES.

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JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

Part II.—PHYSICAL SCIENCE.

No. I.—1879.

I.—*On new species of the Genus* Plectopylis *of the Family* Helicidæ.—*By* LIEUT.-COLONEL GODWIN-AUSTEN, F. R. G. S., F. Z. S., &c., *late Deputy Superintendent Topographical Survey of India.*

(Received October 7th, 1878;—Read March 5th, 1879.)

(With Plate I.)

Since the paper on the shells of this group of *Helices* was published in the Proceedings of the Zoological Society of London, Nov. 17th, 1874, I have had the good fortune to obtain three new species, one from Tenasserim, among a collection of shells made by Mr. O. Limborg, of which a list is being prepared; the other two are from Eastern Assam. I give a plate, drawn with the aid of the *camera lucida,* shewing enlarged the arrangement of the internal *plicæ*, which differ materially from all those I have as yet examined and figured; these differences form the best of characters by which the species may be determined. Some conchologists may be inclined to doubt the persistence of these internal characters; personal observation is, however, the best means of settling such a point. Having a very large number of *P. brachydiscus*, described below, I set to work and broke open 42 specimens without finding the very slightest variation; of *P. brahma* thirteen were examined with the same result; there is some slight variation in the young, but only in so far that the barriers shew an undeveloped state, the general arrangement being the same. In *P. achatina,* I found perfect similarity in some 12 specimens, and the result has been similar in all other species that I have examined. I think we may therefore feel certain that such internal structures, depending as they do on the form of the

animal, its mantle and secreting organs, will be as persistent as the shell itself, and that their form and relative positions being more complicated and more pronounced than mere outward shape, any divergence in the former is of importance and more noticeable and noteworthy in a specific sense. The animal, I am sorry to say, I have never had an opportunity of examining very closely.

P. shanensis, Stoliczka, (J. A. S. B., 1873, p. 170,) overlooked in my first paper, is I find, the same as *P. trilamellaris*, which I described in the P. Z. S., Jany. 1874, from Burmah; so this last title will not stand. Ferd. Stoliczka's fine collection of shells passed to the Indian Museum, and Mr. G. Nevill compared the two shells and settled their identity. It should be placed after No. 12, *perarcta*.

Helix *(Plectopylis)* **brachydiscus,** n. sp. Plate I, fig. 1.

Shell dextral, umbilicus very open and shallow, very discoid, rather strong, dull umber-brown, epidermis thick with a cloth-like texture, finely and beautifully ribbed longitudinally; in young fresh shells the upper outer margin is closely set with a strong regular epidermal fringe about ·075 inches long. Spire quite flat, approaching the concave in some specimens, the apex itself having a subpapillate form. Whorls 7, the last rather flat on the side and angular above, descending at the aperture, which is very oblique and oblate. Peristome strongly reflected, thickened, white, the margins connected by a well raised ridge, notched above and below. A long horizontal lamella is given off from the upper middle portion of this towards the vertical parietal lamina, but only extends for 0·20 inches, then terminates, but at ·15 inches is again developed, becoming thicker and higher as it approaches the vertical lamina and ending just short of it, in this respect being similar to *P. perarcta*.

The parietal vertical lamina is pointed above and gives off from the lower basal end a short lamella towards the aperture, and a very slight short thin, free lamina is to be seen just below the vertical barriers. Palatal teeth simple, six, the 2nd, 3rd, 4th and 5th, are the best developed, the 1st and last are small, 2nd the longest.

Animal not observed.

The measurements of the specimen drawn and of the largest specimen are respectively—

Major diam. 0·82. Minor diam. 0·68. Alt. at axis about 0·24 and
„ „ 0·95. „ „ 0·83. „ „ „ 0·28.

Hab.—This shell was found by Mr. O. Limborg on the high range of Mulé-it, east of Moulmein, Tenasserim, and in the neighbourhood. He collected an immense number in a dead bleached state, but only a dozen in a fresh state; the others were, however, exceedingly valuable for proving, as above shewn, the persistency of the internal structure in all.

This form should be placed between No. 11, *P. pseudophis*, and No. 12, *perarcta* in my key to the species, *vide* P. Z. S., 1874, pp. 612, 613.

Helix (*Plectopylis*) **Oglei,** n. sp., Plate I, fig. 2.

Shell dextral, widely umbilicated, sub-discoid, dull pale brown with close-set sienna markings crossing the whorls. Epidermis thick and nacreous, and somewhat rough. Apex flat but slightly concave, the whorls rising regularly. Whorls 8, the last descends slightly near the aperture, which is very oblique and ovate. Peristome slightly reflected, white, continuous on the body whorl, but not strongly developed. Palatal teeth 6, 3rd, 4th and 5th equal, 6th longer, double. On the parietal side is one single vertical lamina with buttress-like supports on posterior side above and below.

Major diameter 0·65 ; minor diam. 0·58 ; alt. axis 0·25 inches.

Hab.—The above shell was discovered near Sadiya, Assam, by Mr. M. T. Ogle of the Topographical Survey, after whom I have much pleasure in naming it. Mr. Ogle collected and sent me a very fine collection of land-shells from this eastern part of the Assam valley, comprising many new and interesting species, which I am engaged in working out. The nearest species to *P. oglei* is *serica* of the Burrail Range, but the former is very much larger and may be known at once by its less flattened form and darker rougher surface. In the synoptical table of this sub-genus, P. Z. S., 1874, p. 612, this shell should follow No. 1, *P. serica*, G.-A.

Helix (*Plectopylis*) **brahma,** n. sp., Plate I, fig. 3.

Shell sinistral, rather closely umbilicated, discoidal, pale ochry-brown, finely and regularly striate. Apex flat yet slightly convex. Whorls 7, last angular above and rounded below, slightly compressed behind the aperture and hardly descending. Aperture lunate, oblique. Peristome slightly reflected and thickened, white, continued as a callus on the body whorl.

Internal structure complicated ; the parietal vertical lamina is strong and gives off a short horizontal lamella at the lower end ; above this are two other and parallel *free* lamellæ,* both short, the lower being the best developed ; the upper is occasionally united to the upper end of the vertical barrier. There is a very thin thread-like lower free lamella extending to the peristome and uniting with the parietal callus. The palatal *plicæ* are arranged in two rows, those of the anterior row are few and large, four in

* In three cases out of twelve I examined, the upper *lamella* was united to the vertical barrier, but this does not affect the order of position and arrangement of all these processes in this species.

number, the two upper long, narrow and adjacent, the 3rd is a flattened dome-like mass, the 4th is long and curving inwards. Behind this at a short distance is the second row, consisting of fourteen very minute, closely arranged, thin, longer or shorter tooth-like processes, those on the upper side being slightly the largest.

Major diam. 0·35; minor diam. 0·32; alt. axis 0·2 inches.

HAB.—This very interesting new form was also obtained by Mr. Ogle near Brahmakhund, eastern Assam, at 1,000 feet elevation.

The arrangement of the internal barriers is unlike any species of this sub-genus I have yet examined, and shews a decided departure from the usual North-East Frontier forms, a sort of foreshadow that in the mountains further east this particular development is to be found of a like or more marked character.

In external form the present species resembles *P. shiroiensis*, but may be distinguished from it by the coarser epidermis and more regular striation, and the broader wider size of the last whorl near the aperture, shewing no constriction. It is of interest to note that the flattened dome-like barrier on the palatal or mantle side coincides with the vertical barrier in *P. shiroiensis* where we see the distinct result of two teeth fused as it were together.

This species should come in after No. 18, *P. refuga*, var. *dextrorsa*, as a sub-section *b′* of group B of the key in P. Z. S. Palatal vertical *plicæ* only compound, in two rows, numerous. Horizontal parietal *laminæ* short.

II.—*On the Operations for obtaining the Discharges of the large Rivers in Upper Assam, during Season* 1877-78.—*By* LIEUT. H. J. HARMAN, R. E., *in charge Assam Valley Series, Survey of India. Communicated by* MAJOR-GENL. J. T. WALKER, R. E., C. B., F. R. S., *Surveyor General of India.*

[One of the Survey Operations during the field season of 1877-78 was to explore as much as possible of the region between the Subansiri and the Dihang Rivers, with a view to ascertaining which of these two affluents of the Brahmaputra river had the best claim to be considered the recipient of the Sanpo River of Thibet. As there was reason to fear that political difficulties might intervene to prevent the survey officers from proceeding a sufficient distance into the interior to settle this disputed point, Lieut. Harman was directed to measure the discharges of the several rivers at various points, and to ascertain the volume of water in each river in order that additional evidence might be forthcoming on an interesting geographical problem. The following paper gives the details of these operations.

J. T. W.]

The first river measured was the Subansiri. The method of procedure was as follows, and the same method of work was adopted for all the other rivers :

A gauge-post was planted in the bed of the stream to note the variation in level of the water during the operations. Four parallel lines were laid out across the river, at a perpendicular distance apart of 758 ft., the shore portions of the lines being marked by flags (vide fig. 1).

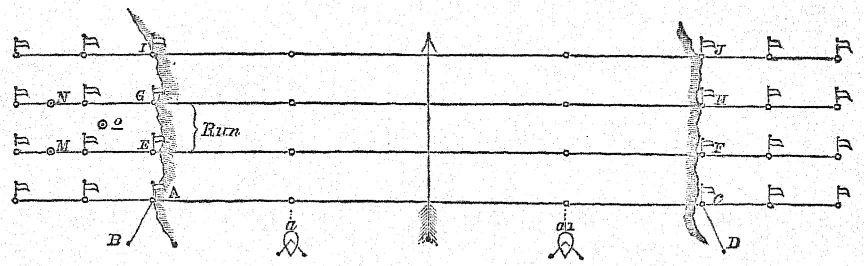


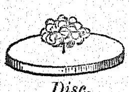
Fig. 1.

Base lines A B and C D were measured, and on a plane table a chart was made on the scale of 70 feet = 1 inch showing the lines of flags and the margins of the river. The section was obtained in the following manner:

A small dug-out (canoe) was anchored at (a) and the cable eased off until the observer (myself) in the boat was exactly on the upper or first line A C. A signal was made to an assistant stationed with the plane table at *B* or *D*, who at once cut in the position of the observer in the boat on the line A C. Soundings were then taken, and the boat let down to the 2nd line or upper line of the "Run." The position of the observer in the boat was again cut in and soundings were taken ; and so on for the remaining two lines. The boat was then hauled up, the grapnel raised, and a new position (a_1) taken up.

It was found that in most cases, the line joining the four sounding stations obtained from one anchoring position, closely agreed in direction with the surface flow of the water at that part of the river.

The instruments for measuring velocities were discs of wood 3 in. diameter and $\frac{1}{4}$ in. thick, marked by a little mass of cotton wool thrown over a peg standing upright in the centre of the disc (fig. 2). Also tin tubes, 1 in. diameter, closed at one end, varying in length from $2\frac{1}{2}$ to 10 ft., containing enough water to sink the tubes, so that only 3 or 4 inches



Disc.

Fig. 2.

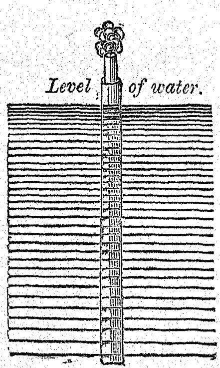


Fig. 3.

of them remained above water (fig. 3). In the mouth of the tube was a cork and some cotton wool for a marker. I obtained from Calcutta a number of hollow balls 3 in. diameter, for sub-surface velocity measurements: I did not get them till February and found that unfortunately they were defective and were of little use to me.

I had also a current-meter by "Casella," with which I intended observing sub-surface velocities. Capt. Willans, R. E., Executive Engineer, Shillong, very kindly designed and had made up for me an effective apparatus, a lift by which the current meter could be lowered and fixed to any desired depth in the water, could be started and stopped at pleasure, and raised easily to allow of the record being read off. Unfortunately, when too late, I found that the meter would not work except with a very high velocity of water, and those records obtained were untrustworthy.

The method of measuring the velocity was as follows:—

The boat was moored on the upper line A C (vide Fig. 1), and the floating instruments dropped into the water. The general line of direction taken by the floats was observed with a prismatic compass; on the bank were two observers M and N, each furnished with a good pair of binoculars. A recorder, with a large chronometer (Dent's) beating half seconds, was seated at *O*.

The flag staves were thin and straight. When the observer M saw a float cross his line E F he cried "*past*," and the recorder at *O* noted the time in his book: when the float passed the line G H, the observer *N* cried "past" and the recorder noted the time. The interval between the two noted times, gives the time taken by the float to pass over the "Run."

The following example shows the method of computation adopted in the majority of cases: of course it sometimes happened that the section of the bed of the river between adjacent sections where velocities were taken was as in fig. 4, or the direction of the flow of the water at *a* differed greatly from that at *b*, or the observations at one of the Sections were untrustworthy; in such cases modifications were necessary and methods recommended by one's judgment were resorted to; but the following example gives the type of computation adopted in most cases:—

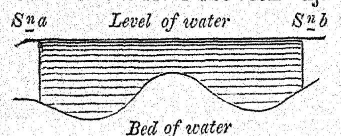


Fig. 4.

The length of run = 50 feet.

From chart the length $c\ e = 200$ feet (vide Fig. 5). Make c G = Ge.

Through G draw G K, showing a mean direction of flow of floats, *i. e.* 265°.

Draw $f\ G\ h$ perpendicular to G K and the lines cf, eh perpendicular to $f\ g\ h$.

Then for computation of discharge; the area of the section from c to e is very nearly $\left[200 \times \text{Cos } 9^\circ \times \left(\frac{12 + 10}{2}\right)\right] = \text{A}.$

From the velocity measurements—

The meantime of passage of 10 discs thrown in at $c = 12{\cdot}5$
6 tubes, each 10 ft. long, at $c = 14{\cdot}5$
4 " " 3 ft. long, at $c = 12{\cdot}0$

.... of 12 discs thrown in at $e = 12{\cdot}0$
4 tubes, each 8 ft. long, at $e = 14{\cdot}5$
3 " " 3 " at $e = 12{\cdot}0$

Assumed meantime of passage for section is 13·5—

The mean velocity per second required for section is $\frac{50 \times \text{sec. } 9^\circ}{13{\cdot}5} = \text{V},$

and AV = discharge, or number of cubic feet of water passing through c to e in one second of time.

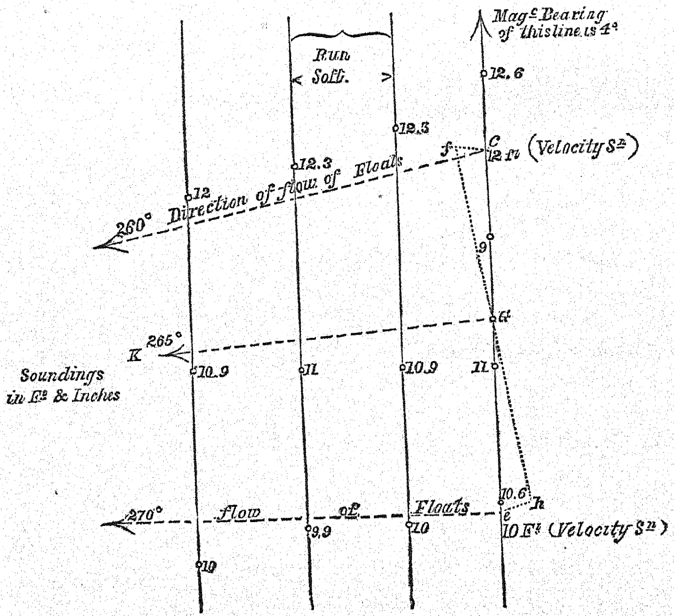


Fig. 5.

There is a clumsiness in the formula, but no alteration has been made, because I set up all the quantities for giving the discharges before it was noticed. The values of the discharges are not affected, but I may as well note how the formula took its shape.

Let M N O P (Fig. 6) be an open channel of considerable length, the flow of water uniform, the section of the channel rectangular.

Let cd and ef be two lines parallel to each other, at a perpendicular distance apart equal to gh. ab is a section at right angles to length of tube and to the direction of flow of water.

Let the angle $egi = 90° + \theta$, and v be the depth.

Let t be the time in seconds taken by a particle of water to move from g to K.

Then the Discharge through the section $cd = \dfrac{cd \times v \times gh}{t}$.

The Discharge through $ab = cd \times cos\ \theta \times v \times \dfrac{gh \text{ sec. } \theta}{t}$ (1) $= \dfrac{cd \times v \times gh}{t}$

It is this formula (1) which has been employed.

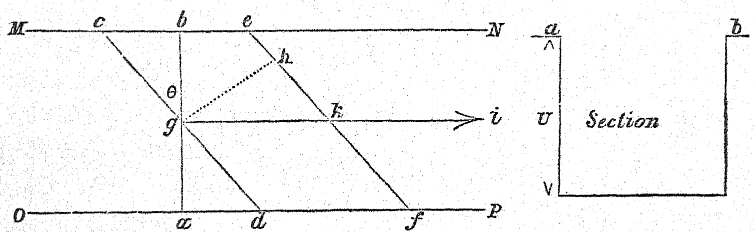


Fig. 6.

(a) The line of maximum velocity of a river is found at a short distance below the surface. The velocity at the bottom of a river is less than the surface velocity; the retardation is great if there are many weeds.

The bottoms of all the rivers measured were of coarse heavy sand, excepting a short stretch of big pebbles in the bed of the combined Dihang and Dibang rivers.

Professor Rankine assumes that the mean velocity on a vertical line, is to the greatest velocity on the same line, as 3 to 4 for slow rivers and 4 to 5 in rapid streams.

The velocity of a rod extending to nearly the bed of the stream is approximately the mean velocity of the water in the vertical plane traversed by the rod. In assigning a mean velocity for computation to the several portions of the sections of the rivers, all the above facts were kept in view.

At some sections of observation for determining velocity, many different instruments were used and many passages made; at other sections only a few observations were made.

(*b*) The arithmetical mean of the times noted at a station of the passages of a certain floating instrument, was taken as the mean time of passage of that instrument. The record of times was kept to half seconds, and it is rarely that discrepancies of over 1 second from the mean occur. These discrepancies were due, first to errors of observation and 2ndly to considerable divergence of the floating instrument from the general line taken. Having obtained at a station the mean time of passage of each kind of instrument, and having regard to the number and quality of the observations, a value was assumed as representing the mean time of passage of the water at that station.

For the adjacent station, a mean time of passage was obtained in a similar manner. Then for the whole included section, a value was assumed as representing the mean time of passage, and this value was employed in the computation.

In such a case as the following: at station (*a*) the velocity of the water is high, and the swift water extends nearly to the adjacent station *c*, and shows a well defined margin-line of the current. At station *c* the velocity is low.

In such cases the section from station (*a*) to station (*c*) is sub-divided into 2 parts; the swift water portion is dealt with by itself, the remaining part by itself.

The method adopted of obtaining the data for computation gives, I think, the results required, and without much labour.

(*c*) The Flood Discharges are merely probable values. They were obtained in the following way. The section lines were laid down on the Revenue Survey large-scale maps of the rivers. An examination was made on the ground to see what changes had taken place since the maps were made. All vertical heights on these flood sections (shown on charts of river sections) were estimated. The flood section was then divided into portions, and an assumed velocity was assigned to each portion, the value being chiefly determined by the section of the portion, its position, and from what local information I could gather. The main-stream high flood velocity has been taken at 7 feet per second. To obtain the total Flood Discharge it was necessary to increase the velocities of each portion of the dry season section. After once assuming values for the flood velocities of the different portions, no alterations were made subsequently.

(*d*) Some of the rivers measured, were above the mean low-level of the dry season. To obtain the discharge of the river at its mean low-level of the dry season, the following method was adopted: the area of each portion of the section, due to rise, was computed and subtracted from the observed area of that portion; then, to the diminished area of the portion, a mean velocity was given which was less than the observed mean velocity

of the portion. After velocities have been once assumed they have not been reconsidered or altered.

In the case of the reduction of the observed discharge of the Dibang river, to its mean low-level discharge of the dry season, the rise of water was taken as 4 feet, but subsequently it was taken as 5 feet.

The depths along the section of the Brahmaputra above Sadiya were all obtained on the same day. The velocity observations at some of the stations were made when the river had risen 1 foot to 1½ feet: reductions were therefore made to the observed velocities at these stations.

(*e*) The columns in the Synopsis Table, headed "Mean Velocity of river at its mean low-level of the year," and at "high flood level," do not contain much information unless they are compared with the sectional areas, and form of section.

The sum of the discharges of the rivers forming the Brahmaputra river should equal the discharge of the Brahmaputra itself. The work done fulfils this test sufficiently nearly to allow, I think, of the stated discharges being considered as sufficiently approximate for geographical purposes.

The Subansiri measurements were made between the 25th and 28th of February 1878. The weather was fine for the work, the level of water constant; very little wind disturbed the observations. The boatmen and others living at the site of the section stated that the water was very rarely seen at a lower level, and that during the observations it was at the dead-low of the dry season.

Ninety soundings were made to obtain the section of the stream; at 21 stations observations were taken for velocity and there were 510 recorded passages of the floating instruments. The resulting discharge at lowest level of the year was found to be 16,945 cubic feet per second: the superficial area of the section 9,637 superficial feet, so that the mean velocity of the water was 1·7 feet per second.

During the very high floods of the year the water is known to rise 22 feet, but calculations have been made for ordinary high flood, taken at 16 feet; with this rise of water I have computed the discharge to be at least 170,000 cubit feet per second; area of section is 35,700 superficial feet, so that mean flood velocity is 4·7 feet per second.

For extreme floods, 13,000 superficial feet must be added to the section area and 70,000 cubic feet to the discharge, which would bring the maximum discharge up to 240,000 cubic feet per second, and sectional area to 48,700 superficial feet.

The site of the section was at Pathalipam village, 3 miles west of Gogah-muk ferry, and about 10 miles from the foot of the hills, from the gorge where the river issues out into the plains.

Before issuing into the plains, the river flows gently for 9 miles in a

great chasm; the depth of the water may be taken at 60 feet, (the few soundings taken were 66 to 70), mean width 90 yards, and velocity fully 1 foot per second. Such dimensions give a discharge equal to the measured discharge; but I am of opinion that had I selected my site at the place where the river leaves the hills, I should have obtained a greater discharge than the one I measured, on account of loss by percolation through the sand.

The Subansiri after leaving the hills spreads out into several sandy channels, which unite above Gogah-muk. At Gogah-muk the river flows in one channel and turns abruptly from a north to south course into a west by north course.

The next river measured was the Brahmaputra river, at a site due north of, and 3 miles distant from Dibrugarh Church. There was a rise in the river just before the measurements were made, but the work was done at the low level of the year, and the observations were made at favorable times. On account of the wind and the rapidity of the current, the work occupied me from March 11th to 18th. In the rapid parts of the river, where the velocity was 5 feet per second, a light canoe manned by four men could not make way up-stream, and it was therefore generally necessary to have the boat brought in shore, poled up-stream and then dropped down into position: a position once missed could only be regained by going in shore again.

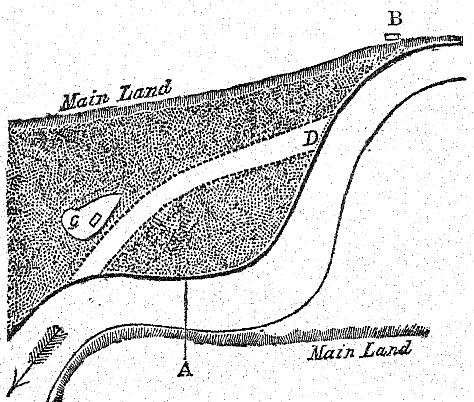


Fig. 7.

The site selected, though favourable for the operations, unfortunately did not include the entire volume of the river: the blunder happened in this way:

Between the site *A*, (Fig. 7) and the Miri village of Saenga Jan (B) is a distance of 3 miles. During the cold season of 1876-77 there was a wide channel D in the sands, its mouth was choked with sand; a little way down the channel the water was less than knee-deep and the flow very slight.

Before commencing work I sent men to see the channel and they reported it shallower than it was in the preceding year: just before closing work I found that at the village *C* the channel was wide, breast deep and the flow slow. To allow for this unmeasured percolation through the sands I have added to the measured discharge of the Brahmaputra 3000 cubic feet per second to bring the result nearer the truth. The "Buri Suti" channel for two miles from its mouth has no water in it, but at 15 miles from its mouth it is rarely fordable.

After the work was finished on March 19th there was a rise of 6 feet in the river, and at Gauháti on March 24th it caused the gauge register to read 4.6 ft. above the zero.

For the section, 120 soundings were taken: observations for velocity were made at 14 stations, and there were 255 recorded passages of the floating instruments.

The resulting discharge at the low level of the year was found to be 113,115 cubic feet per second; the superficial area of section was 24,477 superficial feet, so that the mean velocity of the water was 4.6 feet per second. To the observed discharge, 3,000 cubic feet must be added for percolation through the sands and flow through the channel D, mentioned above, thus bringing the discharge up to 116,115 cubic feet per second.

During very high floods the water rises 20 feet, but calculations have been made for an ordinary high flood rise of 16 feet, which gives a discharge exceeding 830,000 cubic feet per second, a sectional area of 164,000 superficial feet, so that the mean velocity of the flood is 5 feet per second.

For an extreme flood the discharge would exceed 1,100,000 cubic feet per second, and the sectional area 208,000 superficial feet. For a rise of 3 feet over the low level of the year, the increased section would be 14,100 superficial feet and the increased discharge 54,000 cubic feet per second.

The next river measured was the united stream of the Dihang and Dibang rivers, at one mile above the junction with the Brahmaputra and one mile below the mouth of the Dibang river. At the time of measurement the river was somewhat less than 3 feet above the low level of the year.

The weather was fairly favourable and the site selected was a good one. The work was done between March 24th and 27th of 1878.

For the section, 59 soundings were taken, observations for velocity were made at 12 stations, and there were 170 recorded passages of floating instruments.

The resulting discharge was 110,011 cubic feet per second, sectional area 25,105 superficial feet, so that the mean velocity was 4·4 feet per second.

The river at time of measurement was 3 feet above the minimum level of the year. The increased section due to this 3 feet rise, is computed to be 6,222 superficial feet, and the increased discharge to be 27,359 cubic feet per second; thus the cold weather low-level discharge of the united streams is 82,652 cubic feet, sectional area 18,883 superficial feet, mean velocity 4·3 feet per second.

To obtain the cold weather low level discharge of the Dihang river it is necessary to subtract the Dibang discharge, shown below to be 27,200 cubic feet per second, and this quantity subtracted from the discharge of the united streams will give the Dihang discharge to be 55,400 cubic feet per second at minimum level of the year.

During very high floods the united rivers rise 20 feet, but the calculations have been made for an ordinary high flood rise of 15 feet which gives a discharge of 485,000 cubic feet per second, a sectional area of 84,000 superficial feet and consequent mean velocity of 5·7 feet per second.

To obtain the flood discharge of the Dihang river, it will be necessary to subtract that of the Dibang river which is shown below to be 122,483 cubit feet per second, which amount subtracted from the above 485,000 cubic feet leaves for the ordinary flood discharge of the Dihang river 362,517 cubic feet per second.

The next river measured was the Dibang river at one mile above its mouth and half a mile below the mouth of the Senseri river.

The work was done on the 27th March 1878 when the river was 5 feet above the low level of the year. This river receives a good deal of snow-water, from snowy mountains close to the plains. After a hot day the river will rise during the night 2 to 3 feet, subsiding during the morning. This is not the case in the Dihang river.

There were 37 soundings taken for the section. At 9 stations observations were made for velocity, and there were 116 recorded passages of floating instruments.

The measured discharge was 47,383 cubic feet per second, sectional area 10,992, and therefore mean velocity 4·3 feet per second. But at time of measurement the river was 5 feet above minimum level of the year, and this 5 feet rise has been computed to produce an increased sectional area of 4,617 superficial feet and discharge of 20,181 cubic feet.

Thus the discharge of the Dibang river + Senseri river at the low level of year is 27,202 cubic feet per second, sectional area 6,375 superficial feet and mean velocity 4·2 feet per second. But the Senseri river brings down about 1,200 cubic feet, so that the low level discharge volume of the Dibang river is 26,000 cubic feet per second.

During the high floods the river rises 20 feet, but like the Dihang computations an ordinary flood of 15 feet has been calculated for, and

then the flood discharge is 122,483 cubic feet per second, sectional area 23,692 superficial feet, and mean velocity 5·2 feet per second.

For an extreme flood of 18 feet, the discharge would exceed 144,000 cubic feet, the sectional area be 27,700 superficial feet, and mean velocity 5·2 feet per second.

The next river measured was the Brahmaputra river at about 9 miles above Sadiya and half a mile below the mouth of the united stream of the Tengapáni aud Noa Dihing rivers. There was a good deal of difficulty found in the measurement of this river on account of bad weather and the level of the water not remaining constant. The section was made when the river was at 3 feet above the low level of the year, but most of the velocities were measured when the river was at a slightly higher level. These facts were kept in view when the calculations were made.

The measurements were made between April 2nd and 6th of 1878. For the section, 61 soundings were made, observations for velocity were taken at 14 stations, and there were 165 recorded passages of floating instruments.

The measured discharge was 66,251 cubic feet per second, sectional area 16,396, so that the mean velocity was 4 feet per second. At time of measurement the river was 3 feet above the minimum level of the year: the increased volume due to this rise was computed to be 32,419 cubic feet per second, and sectional area 8,168 superficial feet; so that the mean low-level dry season discharge of the Brahmaputra river below Tengapáni-muk is 33,832 cubic feet per second, sectional area 8,228 superficial feet, and, consequently, mean velocity 4·1 feet per second.

To obtain the minimum discharge of the Brahmaputra at the Brahmakund, it will be necessary to deduct from the above figures, the cold season mean low-level volume of the Tengapáni and Noa Dihing (which is stated below to be 3,000 cubic feet per second), and that of the Digaru river which I would estimate from hearsay at 5,000 cubic feet per second. Thus the minimum discharge of the Brahmaputra at the Brahmakund would be 25,000 cubic feet per second.

The ordinary high flood of the Brahmaputra below Tengapáni-muk has been calculated at 16 feet. It gives a discharge of 293,000 cubic feet per second, a sectional area of 53,017 superficial feet and mean velocity of flood 5·5 feet per second. For the flood discharge at the Brahmakund one should subtract from above discharge 53,000 cubic feet for the Tengapani and Noa Dihing rivers (vide below), and I would estimate 60,000 for the Digáru river, which would leave 180,000 cubic feet per second for flood discharge of the Brahmaputra at the Brahmakund.

For an extreme flood of 18 feet the discharge below Tengapáni-muk would be over 326,000 cubic feet per second, sectional area 59,000 superficial feet and mean velocity 5·5 feet per second; then calculating by pro-

portion, the extreme flood of the Brahmaputra at the Brahmakund would be not less than 200,000 cubic feet per second.

Before closing work at Tengapáni-muk I thought it well to make a measurement of the united stream of the Tengapáni and Noa Dihing rivers. This I did on the 6th April 1878 at a site 200 yards below the junction of the Tengapáni and Noa Dihing rivers. At the time of measurement the water was fully 3 feet above mean low level of the year, and more than half of it came from the Noa Dihing river.

For the section 18 soundings were made, observations for velocity were taken at 2 stations and there were 19 recorded passages of the floating instruments.

The measured discharge was found to be 6,807 cubic feet per second, sectional area 2,203 superficial feet, mean velocity 3·1 feet per second.

At the time of measurement the river was 3 feet above minimum level of the year; it is computed that for the low level of the year the discharge is 3,000 cubic feet, area of section 900 superficial feet, and velocity 3·3 feet per second; and of this 3,000 cubic feet, 2,500 cubic feet comes from the Tengapáni river.

For an ordinary high flood rise of 15 feet, the discharge is computed to be 53,000 cubic feet per second, sectional area 10,400 superficial feet and mean velocity 5·1 feet per second.

For an extreme flood rise of 18 feet, the discharge is 65,000 cubic feet, sectional area 12,800 superficial feet and mean velocity 5·1 feet per second.

From the Synopsis Table attached, it will be seen how closely the sum of the volumes &c, observed, for the two great streams which form the Brahmaputra River, agree with the observed volume of the river at Dibrugarh. The river at Dibrugarh should be of greater volume than the combined Dihang and Sadiya streams, because of the Lali channel of the Dihang which joins in just below the place where the section of the Dihang and Dibang was taken. During the cold season, and at time of observations it was a small and fordable stream 100 yards wide, but during floods the channel brings down a very large volume of water.

During the floods a considerable volume of water passes down the Buri Suti, the mouth of which is on the north bank and between Dibrugarh and the mouth of the Dihang river.

The Buri Suti falls into the Brahmaputra near the mouth of the Dihing river, south of Dibrugarh.

I have endeavoured to be as moderate as possible in my estimates of the flood discharges, but I think it may fairly be stated that at Poba, a few miles above the mouth of the Buri Suti, there is every season a flood when $1\frac{1}{2}$ million cubic feet per second passes down the Brahmaputra. The rise of the flood I have calculated at 15 to 18 feet. The rise at Gauháti is 28 to 30 feet.

Synopsis Table. Results of

Name of River.	Discharge in cubic ft. per second at mean low level of the year.	Sectional area in Sup. ft. at mean low level of the year.	Mean velocity in feet per second at mean low level of the year.	Discharge at ordinary High Floods.	Sectional area at ordinary High Floods.	Mean velocity in feet per second at ordinary High Floods.	Discharge at extreme High Floods.
Dihang + Dibang River,..	82,652 (*d*)	18,883 (*d*)	4·3 (*d*)	485,000 (*d*)	84,000 (*d*)	5·7 (*d*)	567,000 (*e*) (18 ft. rise)
Brahmaputra River, above Sadiya and below mouth of the Tengapáni River.	33,832 (*d*)	8,228 (*d*)	4·1 (*d*)	293,000 (*d*) (16 ft. rise)	53,017 (*d*) (16 ft. rise)	5·5 (*d*)	326,000 18 ft. (*e*)
Total,....	116,484	27,111	4·2 about	778,000	137,017	5·6 about	893,000
Brahmaputra River at Dibrugarh. *	116,115 (*o*)	24,477 (*o*)	4·6 (*o*)	830,000 (*d*)	164,000	5·0	1,100,000 (*e*)
Difference,....	—369	....	....	+ 52,000	....	....	+107,000
Dibang River, below mouth of Senseri River.	27,202 (*d*)	6,375 (*d*)	4·2 (*d*)	122,483 (*d*)	23,692 (*d*)	5·2 (*d*)	144,000 18 ft. rise
Senseri River, ...	1,200 (*e*)	....	....	12,000 (*e*)	....	....	14,000 (*e*)
Dihang River (less the Lalisuti.)	55,400 (*d*)	....	....	362,517 (*d*)	....	....	423,000 (*e*) 18 ft. rise
Tengapáni + Noa Dihing,	3,000 (*d*)	900 (*d*)	3·3 (*d*)	53,000 (*d*) 15 ft. rise	10,400 (*d*) 15 ft. rise	5·1 (*d*)	65,000 (*e*) 18 ft. rise
Tengapáni River, ...	2,500 (*e*)	....	....	22,000 (*e*)	....	....	26,000 (*e*)
Noa Dihing River, ...	500 (*e*)	....	....	....	....	....	....
Digáru River, ...	5,000 (*e*)	....	....	60,000 (*e*)	....	....	75,000 (*e*)
Subansiri River, ...	16,945 (*o*)	9,637 (*o*)	1·7 (*o*)	170,000	35,700	4·7	240,000
Brahmaputra at the Brahmakund.	25,000 (*d*)	....	....	180,000 (*d*) 16 ft. rise	....	..	200,000 (*d*) 18 ft. rise

Note: (*o*) means observed value.
(*d*) „ deduced value by computation.
(*e*) „ estimated value.

Discharge Measurements.

Sectional area at extreme High Floods.	Mean velocity in feet per second at extreme High Floods.	Measured discharge of River, when it was 3 ft. above mean low level of year.	Measured Sectional area when river was 3 ft. above mean low level of year.	Observed mean velocity when river was 3 ft. above mean low level of the year.	Date of Measurements.	Site of Section.	No. of Soundings taken for Section.	No. of Stations at which observations were made for velocity.	No. of recorded Passages of Floating Instruments.	Remarks.
98,000 (*e*) (18 ft. rise)	5·8 (*e*) (18 ft. rise)	110,011 (*o*)	25,105 (*o*)	4·4 (*o*)	1878. 24th to 27th March	1 mile S. of mouth of Dibang river & 1 mile above junction with Brahmaputra.	59	12	170	
59,000 (*e*) (18 ft. rise)	5·5 (*e*)	66,251 (*o*)	16,396 (*o*)	4·0 (*o*)	April 3rd to 6th.	9 miles above Sadiya and ¼ of a mile below the mouth of the Tengapani River.	61	14	165	
157000	5·7 about	176,262	41,501	4·2 about						
208000 (*e*)	5·3 (*e*)	170,915	38,500	4·4	March 16th, 17th, 18th.	at a place due N. of and 3 miles from Dibrugarh.	120	14	255	* Vide Memoir, Page 15.
....	....	—5,347	....	....						
27,700 (18 ft. rise)	5·2	47,383 (*o*) at 5ft. above mean low level of the year.	10,992 (*o*) at 5 ft. above mean low level of the year.	4·3 (*o*) at 5 ft. above mean low level of the year.	March 27th.	¼ mile below the mouth of the Senseri River.	37	9	116	
....	....	....	....	....	....					
....	....	....	....	....	....					
12,800 (*e*) (18 ft. rise)	5·1 (*e*)	6,807 (*o*)	2,203 (*o*)	3·1 (*o*)	April 6th.	200 yards below junction of Tengapani River with Noa Dihing River.	18	2	19	
....	....	2,500 (*e*)	....	....	....					
....	....	4,307 (*e*)	....	....	....					
....	....	....	....	....	....					
48,700	4·9	....	....	....	....					
....	....	....	....	....	Febr. 25th to 28th.	Pathalipam village, 3 miles west of Gogah Muk.	90	21	510	
							385	72	1,235	

H. J. Harman, Lieut. R. E.
Survey of India.

October, 1878.

SUBANSIRI RIVER.

Computations of Discharge.

Observations taken February 26th, 27th, 28th of 1878.
Length of Run 50 feet. Magnetic Bearing of Section lines 330°.

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (Mag.) (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of Floats at Stations. (8)	Mean time of Passage, for Computation. (9)	Multiplication.	Area of portion. (10)	Discharge per second through portion. (11)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
left bank to 63	0 4	140	140	2	.. ..	..	35	40·0	$140 \times 2 \times \frac{50}{40}$	280	350
63 to 62	4 7	75	74	5·5	.. 250°	8°	35 24	30·0	$74 \times 5{\cdot}5 \times \sec. 8° \times \frac{50}{30}$	407	685
62 to 64	7 9	78	77	8	250° 255°	$12\frac{1}{2}$°	24 20	22·0	$77 \times 8 \times \sec. 12\frac{1}{2}° \times \frac{50}{22}$	616	1,434
64 to 44	9 10	34	34	9·5	255° 255°	15°	20 19·5	19·75	$34 \times 9{\cdot}5 \times \sec. 15° \times \frac{50}{19{\cdot}75}$	323	847
44 to 45	10 10·5	42	41	10·25	255° ..	16°	19·5 21·0	20·25	$41 \times 10{\cdot}25 \times \sec. 16° \times \frac{50}{20{\cdot}25}$	420	1,079

45 to 61	10·5 12	64	63	11·25	.. 262°	20°	21·0 22·0	21·50	$63 \times 11{\cdot}25 \times \sec. 20^\circ \times \frac{50}{21{\cdot}50}$	709	1,755
61 to 41	12 10	117	114	11	262° 260°	21°	22·0 28·0	25·0	$114 \times 11 \times \sec. 21^\circ \times \frac{50}{25}$	1,254	2,686
41 to 46	10 12	30	30	11	260° 261°	$20\frac{1}{2}$°	28·0 29·0	28·50	$30 \times 11 \times \sec. 20\frac{1}{2}^\circ \times \frac{50}{28{\cdot}50}$	330	618
46 to 58	12 11	44	44	11·5	261° 257°	19°	29·0 29·0	29·0	$44 \times 11{\cdot}5 \times \sec. 19^\circ \times \frac{50}{29}$	506	923
58 to 47	11 9	76	75	10	257° 260°	$18\frac{1}{2}$°	29·0 31·0	30·0	$75 \times 10 \times \sec. 18\frac{1}{2}^\circ \times \frac{50}{30}$	750	1,318
47 to 65	9 11·5	72	71	10·25	260° 252°	16°	31·0 35·0	33·0	$71 \times 10{\cdot}25 \times \sec. 16^\circ \times \frac{50}{33}$	728	1,147
65 to 48	11·5 11·75	15	15	11·6	252° 254°	13°	35·0 37·0	36·0	$15 \times 11{\cdot}6 \times \sec. 13^\circ \times \frac{50}{36}$	174	248
48 to 66	11·75 12·0	21	21	11·8	254°	13°	37·0 42·0	39·5	$21 \times 11{\cdot}8 \times \sec. 13^\circ \times \frac{50}{39{\cdot}5}$	248	322
66 to 49	12·0 11·75	43	43	11·9	.... 252°	12°	42·0 48·5	45·25	$43 \times 11{\cdot}9 \times \sec. 12^\circ \times \frac{50}{45{\cdot}25}$	512	578
49 to 42	11·75 11·50	34	34	11·6	252° 253°	13°	48·5 47·0	47·50	$34 \times 11{\cdot}6 \times \sec. 13^\circ \times \frac{50}{47{\cdot}50}$	394	426

SUBANSIRI RIVER,—*Continued.*

(1) Station Nos. at extremity of each portion.	(2) Depth at Stations.	(3) Length of portion on section line.	(4) Length of portion for Computation.	(5) Depth of portion for Computation.	(6) Observed flow of floats at Stations. (Mag.)	(7) Angle of Flow of Water for Computation.	(8) Mean time of Passage of Floats at Stations.	(9) Mean time of Passage, for Computation.	Multiplication.	(10) Area of portion.	(11) Discharge per second through portion.
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
42 to 50	11·50 12·0	27	27	11·75	255° 248°	11°	47·0 45·0	46·0	$27 \times 11{\cdot}75 \times \sec. 11° \times \frac{50}{46}$	317	351
50 to 67	12·0 12·25	55	54	12	248°	8°	45·0 36·0	40·5	$54 \times 12 \times \sec. 8° \times \frac{50}{40{\cdot}5}$	648	808
67 to 43	12·25 12·00	40	40	12·25	.... 247°	7°	36·0 36·0	36·0	$40 \times 12{\cdot}25 \times \sec. 7° \times \frac{50}{36}$	490	686
43 to 51	12·00 11·75	12	12	11·9	247° 242°	4°	36·0 32·0	34·0	$12 \times 11{\cdot}9 \times \sec. 4° \times \frac{50}{34}$	143	211
51 to 52	11·75 9·25	18	18	10·5	242°	....	32·0 42·0	37·0	$18 \times 10{\cdot}5 \times \frac{50}{37}$	189	255
52 to 53	9·25 7·00	13	13	8·0	....	....	42·0 50·0	46·0	$13 \times 8 \times \frac{50}{46}$	104	113

53 to right bank	7·0 0·0	27	27	3·5	....	....	50·0	50·0	$27 \times 3{\cdot}5 \times \frac{5\,0}{5\,0}$	95	95
									Total, ...	9,637	16,945

Width of water 1,070 feet. Mean velocity = 1·7 ft. per second.
For Flood Discharge, rise 16 feet, width of water 2,120 feet. Divide it into 4 parts,—

One of 600 feet in width, having a flood velocity of 7 feet per second, gives a discharge of 600 × 16 × 7, ...	67,000
One of 500 feet, depth 16 feet, velocity 6 feet per second, 500 × 16 × 6, ...	48,000
One of 500 feet, mean depth 12 feet, velocity 5 feet per second, 500 × 12 × 5, ...	30,000
One of 500 feet, mean depth 5 feet, velocity 3 feet per second, 500 × 5 × 3, ...	8,000
Flood Discharge, in cubic feet, per second, about, ...	153,000
To above measured discharge, add measured discharge, ...	16,945
Total Flood Discharge at ordinary High Flood, ...	170,000

Area of Section = 35,700 superficial feet, and mean velocity of flood = 4·7 feet per second.

H. J. Harman, Lieut. R. E.
Survey of India.

October, 1878.

BRAHMAPUTRA RIVER

NEAR DIBRUGARH.

March 16*th*, 17*th*, 18*th*, 1878.

Computation of Discharge.

Length of "Run" = 75 feet. Magnetic Bearing of Section lines = $348\frac{1}{2}°$.

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of floats over Run at Station. (8)	Time of Passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
left bank to 109	0 26	50	50	13	....	....	16	18	$50 \times 13 \times \frac{75}{18}$	650	2,708
109 to 106	26 29	70	70	27·50	255°	3°	16 15	15·5	$70 \times 27{\cdot}50 \times \sec. 3° \times \frac{75}{15{\cdot}75}$	1,925	9,327
106 to 103	29 34	55	55	31·5	255° 254°	4°	15 14·5	14·75	$55 \times 31{\cdot}5 \times \sec. 4° \times \frac{75}{14{\cdot}75}$	1,733	8,831
103 to 100	34 35	72	71	34·5	254° 254°	$4\frac{1}{2}°$	14·5 14·5	14·5	$71 \times 34{\cdot}5 \times \sec. 4\frac{1}{2}° \times \frac{75}{14{\cdot}5}$	2,450	12,709
100 to 97	35 31	62	61	33	254° 253°	5°	14·5 15·0	14·75	$61 \times 33 \times \sec. 5° \times \frac{75}{14{\cdot}75}$	2,013	10,275

97 to 85	31 27	61	60	30	253° 253°	$5\frac{1}{2}$°	15·0 14·5	14·75	$60 \times 30 \times \sec. 5\frac{1}{2} \times \frac{7.5}{14.75}$	1,800	9,195
85 to 94	27 20	108	105	23·5	253° 248°	8°	14·5 15·0	14·75	$105 \times 23.5 \times \sec. 8° \times \frac{7.5}{14.75}$	2,468	12,670
94 to 88	20 17	116	112	18·5	248° 247°	11°	15·0 14·5	14·75	$112 \times 18.5 \times \sec. 11° \times \frac{7.5}{14.75}$	2,072	10,733
88 to 91	17 $12\frac{1}{2}$	257	252	14·75	247° 253°	8°	14·5 16·0	15·25	$252 \times 14.75 \times \sec. 8° \times \frac{7.5}{15.25}$	3,717	18,460
91 to 112	$12\frac{1}{2}$ $11\frac{1}{2}$	55	54	12·0	253° 255°	$4\frac{1}{2}$°	16·0 15·5	15·75	$54 \times 12 \times \sec. 4\frac{1}{2}° \times \frac{7.5}{15.75}$	648	3,095
112 to 121	$11\frac{1}{2}$ $9\frac{1}{2}$	107	107	10·5	255° 266°	....	15·5 18·0	16·75	$107 \times 10.5 \times \frac{7.5}{16.75}$	1,123	5,031
121 to 122	$9\frac{1}{2}$ $5\frac{1}{3}$	283	277	7·5	266° 266°	8°	18·0 20·0	19·0	$277 \times 7.5 \times \sec. 8° \times \frac{7.5}{19}$	2,078	8,281
122 to right bank in portions.											
(*a*) 122 station to 51 sounding.	$5\frac{1}{2}$ $3\frac{1}{2}$	80	80	4·5	....	....	....	75	$80 \times 4.5 \times \frac{7.5}{7.5}$	360	360

BRAHMAPUTRA RIVER,—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	*Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Station. (6)	Angle of Flow of Water for Computation. (7)	Mean time of Passage of floats over Run at Stations. (8)	Time of Passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
(*b*) 51 sounding to 57 sounding.	3·5 2·0	277	275	2·75	....	....	....	75	$275 \times 2{\cdot}75 \times \frac{75}{75}$	756	756
(*c*) 57 sounding to near 60 sounding.	2·0 0·0	85	85	1·0	....	....	....	75	$85 \times 1 \times \frac{75}{75}$	85	85
(*d*) near 60 sounding to 66 sounding.	7·0 4·0	87	87	5·5	....	....	....	75	$87 \times 5{\cdot}5 \times \frac{75}{75}$	479	479
(*e*) 66 sounding to edge of sand.	3·25 0·0	80	80	1·5	....	....	....	75	$80 \times 1{\cdot}5 \times \frac{75}{75}$	120	120
									Total, ...	24,477*	113,115*

Width of water 1,881 feet.

For the flood discharge, at ordinary high floods; add to measured discharge:

4

Width of portion in feet.		Depth.		Vely. per second in feet		Discharge per sec. Cubic ft.
900	×	16	×	7·5	=	108,000
900	×	16	×	6	=	87,000
2000	×	12	×	4·5	=	108,000
2000	×	12	×	4	=	96,000
1600	×	16	×	6	=	154,000
1800	×	14	×	4	=	101,000
1500	×	8	×	5	=	60,000

Total, = 714,000

The measured discharge = 714,000

Add for filtration through the sand, and volume of the unmeasured "Suti" (channel), *vide* memoir = 3,000

Total flood discharge exceeds, ... = 830,000 cubic ft. per second; mean flood velocity, 5 ft. per second.

Supfl. area of flood section above measured section = 139,600

" " measured section, ... = 24,477

Total superficial area of the section of river at ordinary flood level, .. = 164,000

Mean velocity 4·6 feet per second.

The measured discharge was obtained at minimum level of the year. The effect of increased volume of river for a 3 ft. rise, above minimum level is—

	50	× 3	×	4·5	=	675
	960	× 3	×	5·5	=	15,840
	283	× 3	×	4	=	3,396
	610	× 3	×	3	=	5,490
Sand covered, ...	400	× 1·5	×	2	=	1,200
Intermediate "Suti,"	1600	× 3	×	4	=	19,200
" Sands,..	1500	× 2	×	3	=	9,000

Total increase in volume of river for a 3 ft. rise above minimum of year is = 54,800 cubic ft. per second.

Increase in area of section in superficial feet = 14·100 Sup. Ft.

* *Vide* memoir: add 3000 ft. for filtration through an unmeasured side channel, which brings the discharge up to 116,000 cubic ft. per second.

UNITED DIHANG AND DIBANG RIVERS.

COMPUTATION OF DISCHARGE.

March 25th—27th of 1878.

Length of Run = 75 feet. Magc. Bearing of Section lines $280\frac{1}{2}$.

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flows of water with Section lines for Computation. (7)	Observed mean time of passage of floats over Run at Station. (8)	Time of passage over Run for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge through portion per second. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Secs.		Sup. Ft.	Cub. Ft.
right bank	0				..		..				
to		196	193	1·5		6°		63	$193 \times 1{\cdot}5 \times \sec. 6° \times \frac{75}{63}$	290	347
59	3				196°		42				
59	3				196°		42				
to		170	170	4·625		4°		34	$160 \times 4{\cdot}625 \times \sec. 4° \times \frac{75}{34}$	786	1,739
58	6·25				192°		26				
58	6·25				192°		26				
to		158	155	8·00		1°		22·5	$155 \times 8 \times \sec. 1° \times \frac{75}{22{\cdot}5}$	1,240	4,134
57	9·75				191°		19				
57	9·75				191°		19				
to		292									
56	12·75				193°		16				
in											
2 portions	(*a*)	167	166	11.25		2°		18	$166 \times 11{\cdot}25 \times \sec. 2° \times \frac{75}{18}$	1,868	7,786
(*a*) & (*b*)	(*b*)	125	123	12·5		2°		16	$123 \times 12{\cdot}5 \times \sec. 2° \times \frac{75}{16}$	1,534	7,211

56 to 55	12·25 11·00	138	137	11·625	193° 195°	4°	16 15	15·5	$137 \times 11{\cdot}625 \times \sec. 4° \times \frac{7.5}{15.5}$	1,593	7,725
55 to (*a*) 51	11 10·5	10.75	77	76	195°	5°	..	15	$76 \times 10{\cdot}75 \times \sec. 5° \times \frac{7.5}{15}$	817	4,101
in 2 parts (*b*) (*a*) & (*b*)	10·33 11·5	11·00	147	146	195° 190°	2°	..	16	$146 \times 11{\cdot}0 \times \sec. 2° \times \frac{7.5}{16}$	1,606	9,533
51 to 52	12 14	333	333	13	190° 190°	0	16 18·5	17·25	$333 \times 13 \times \frac{7.5}{17.25}$	4,329	18,822
52 to 50	14 13·25	295	295	13·625	° 190°	0	18·5 15	16·75	$295 \times 13{\cdot}625 \times \frac{7.5}{16.75}$	4,019	17,997
50 to (*a*) 49	13·25 15·25	90	90	14·25	190° } 185° } 189°	1°	..	14	$90 \times 14{\cdot}25 \times \sec. 1° \times \frac{7.5}{14}$	1,283	6,872
in 2 parts (*b*) (*a*) & (*b*)	15·25 12·25	150	148	13·75	..	3°	..	13·75	$148 \times 13{\cdot}75 \times \sec. 3° \times \frac{7.5}{13.75}$	2,035	11,115
64 to 53	12·0 12·75	153	151	12·4	185° 185°	5°	13 15	14	$151 \times 12{\cdot}4 \times \sec. 5° \times \frac{7.5}{14}$	1,872	10,069

UNITED DIHANG AND DIBANG RIVERS,—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Stations. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flows of water with Section lines for Computation. (7)	Observed mean time of passage of floats over Run at Stations. (8)	Time of passage over Run for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge through portion per second. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Secs.		Sup. Ft.	Cub. Ft.
	12·75				185°		15				
53		140									
to (a)	7·5				175°		50				
54		65	64	10·125		5°		16	$64 \times 10{\cdot}125 \times \sec\ 5° \times \frac{75}{16}$	648	3,049
in 2 parts (b)		76	74	7.5		10°		48	$74 \times 7{\cdot}5 \times \sec.\ 10° \times \frac{75}{48}$	555	881
54 to left bank	7·5 / 0	180	3·5	..	..	..	..	75	$180 \times 3{\cdot}5 \times \frac{75}{75}$	630	630
									Total,	25,105	110,011

Total width of water 2,510 ft. Mean velocity in ft. per second 4·4 ft.

For Flood Discharge at the ordinary High Floods add:

300 × 13 × 5	=	19,500
2500 × 15 × 7	=	262,500
600 × 14 × 5	=	42,000
200 × 16 × 6	=	19,200
800 × 13 × 5	=	52,000
200 × 9 × 4	=	7,200
		402,400
The measured Discharge		82,652

Flood Discharge of Dihang + Dibang Rivers 485,000
From this subtract Flood Discharge of Dibang 122,483

Flood Discharge of Dihang 362,517

	Sup. Feet.	
Area of Flood Section above measured Section	65,200	
Add area of Section at minimum level of year (see below)	18,883	
Total area of Flood Discharge of united Dihang and Dibang,......	84,000	The mean velocity is 5·7 ft. per second.

At time of measurement the river was 3 ft. above minimum level of year.
The increased volume above minimum discharge due to this rise of 3 ft. is

$170 \times 3 \times 3{\cdot}5 =$	1,785	
$654 \times 3 \times 5{\cdot}0 =$	9,810	
$628 \times 3 \times 4 =$	7,536	
$391 \times 3 \times 5 =$	5,865	
$65 \times 3 \times 5 =$	975	
$76 \times 3 \times 2 =$	456	
$90 \times 3 \times 1 =$	270	
	26,697	
	347	Add measured volume of water passing over sands not covered at minimum.
	315	
Increase in volume due to a 3 ft. rise over minimum	27,359	
The measured Discharge	110,011	
	82,652	Discharge of Dihang + Dibang at minimum.
The minimum discharge of Dibang	27,200	
Minimum Discharge of Dihang ..	55,452	Cubic ft. per second.

	Sup. Feet.
The increase in area of Section for a 3 ft. rise over minimum level is	6,222
The measured area of Section is	25,105
Thus the area of Section at minimum, of Dihang + Dibang is....................................	18,883

And mean velocity is 4·3 ft. per second.

DIBANG RIVER.

Discharge Computations.

March 27th, 1878.

Length of Run = 50 ft. Magnetic Bearing of Section lines $359\frac{1}{2}°$.

The Station Nos. at extremity of portions. (1)	Depth at Stations. (2)	Length of portions. (3)	Length of portion for Computation. (4)	Depth for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flow of water with Section line for Computation. (7)	Mean time of passage of floats over Run at Stations. (8)	Time of passage over Run for Computation. (9)	Multiplication. (10)	Area of portion in Superficial Feet. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Secs.		Sup. Ft.	Cub. Ft.
right bank to 32	0 16	33	33	10	.. ..	..	11 0	12·0	$33 \times 10 \times \frac{50}{12}$	330	1,375
32 to 51	16 17	68	68	16·5	271° 268°	..	11·0 10·5	10·75	$68 \times 16·5 \times \frac{50}{10·75}$	1,122	5,180
31 to 33 in 2 parts (a) (b) (a)	17 17·5	70	70	17·25	..	..	..	10·5	$70 \times 17·25 \times \frac{50}{10·5}$	1,208	5,750
(b)	17·5 14	146	144	15·75	668° 264°	3°	..	10·5	$144 \times 15·75 \times \sec. 3° \times \frac{50}{10·5}$	2,268	10,815
33 to 30	13 13	62	61	13·0	264° 265°	5°	10·5 11·5	10·0	$61 \times 13 \times \sec. 5° \times \frac{50}{11}$	793	3,618

30 to 29	13 10·25	252	250	11·6	265° 266°	4°	11·5 12·5	12·0	$250 \times 11{\cdot}6 \times \sec. 4° \times \frac{50}{12}$	2,900	12,113
29 to 34	10·25 10·00	17	17	10·13	266° 264°	$4\frac{1}{2}°$	12·5 12·5	12·5	$17 \times 10{\cdot}13 \times \sec. 4\frac{1}{2}° \times \frac{50}{12{\cdot}5}$	172	691
34 to 35	10·0 10·25	88	87	10·13	264° 264°	$5\frac{1}{2}°$	12·5 13·5	13·0	$87 \times 10{\cdot}13 \times \sec. 5\frac{1}{2}° \times \frac{50}{13}$	881	3,405
35 to 36	10·25 6·0	117	116	8·13	264° 268°	3	13·5 15·0	14·28	$116 \times 8{\cdot}13 \times \sec. 3° \times \frac{50}{14{\cdot}25}$	943	3,314
36 to 37	6·0 5·0	46	46	5·5	268° 270°	..	15·0 16·0	15·5	$46 \times 5{\cdot}5 \times \frac{50}{15{\cdot}5}$	253	816
37 to left bank.	5·0 0·0	49	49	2·5	..	..	16·0	20·0	$49 \times 2{\cdot}5 \times \frac{50}{23}$	122	306
									Totals, ..	10,992	47,383

Width of Water = 950 feet. Mean Velocity = 4·3 feet per second.

DIBANG RIVER.

For Flood Discharge of Dibang River.
add to the measured Discharge.

Length of portion in feet.		*Depth.*		*Velocity in Ft. per second.*		
740	×	10	×	7	=	51,800
210	×	10	×	5	=	10,500
400	×	8	×	4	=	12,800
						75,100
The measured Discharge,					=	47,383
Discharge of Dibang River during ordinary High flood,					=	122,483, Cu. ft. per second.

The area of flood Section above level of water during measurements,	=	12,700 S. Ft.
add measured Section,	=	10,992
Area of ordinary High Flood section,	=	23,692 S. Ft.

Hence mean Velocity of flood is 5·2 ft. per second.

At the time of measurement of Discharge the river was 5 ft. above minimum of year; the volume of a 5 ft. rise over the minimum volume of river during the year is—

$379 \times 5 \times 5 = 9,475$
$520 \times 5 \times 4 = 10,400$

19,875
add 306 measured volume of water passing over sands covered by a 5 ft. rise above low level of the year.

20,181—Total increase in volume of the river due to a 5 ft. rise above lowest level of the year.
47,383 observed Discharge.

27,202 Cu. ft. Discharge of Dibang river at minimum.

The area of Section is 6,375 Sup. Ft. and Mean velocity = 4·2 ft. per second.

October, 1878.

H. J. Harman, Lieut. R. E.
Survey of India.

BRAHMAPUTRA RIVER ABOVE SADIYA.

COMPUTATION OF DISCHARGE.

April 3rd to 6th of 1878.

Length of Run = 50 feet — Magnetic Bearing of Section lines $318\frac{1}{2}°$.

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Station. (6)	Angle of flow of water for Computation. (7)	Mean time of passage of floats over Run at Station. (8)	Mean time of passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
right bank to 62	0 14	110	105	9	parallel to right bank.	8°	9·5	10	$105 \times 9 \times \sec. 8° \times \frac{50}{10}$	045	4,771
62 to 63 in 2 parts	14 13·5	143					9·5 10·0				
(a)	$\frac{14}{18}$	98	96	16		8°		9·5	$96 \times 16 \times \sec. 8° \times \frac{50}{9·5}$	1,536	8,164
(b)	18 13·5	47	47	15·75		$8\frac{1}{2}°$		10·0	$47 \times 15·75 + \sec. 8\frac{1}{2}° \times \frac{50}{10}$	740	3,742
63 to 66 in 2 parts	13·5 9·25	285			220° 220°	$8\frac{1}{2}°$	10·0 10·5				
(a)	13·5 13	13·25 (5)	220 (3)	215 (4)		$8\frac{1}{2}°$		10·2	$215 \times 13·25 \times \sec. 8\frac{1}{2}° \times \frac{50}{10·2}$	2,846	14,120
(b)	13 9·25	65	64	11·13		$8\frac{1}{2}°$		10·4	$64 \times 11·13 \times \sec. 8\frac{1}{2}° \times \frac{50}{10·4}$	712	3,463

BRAHMAPUTRA RIVER ABOVE SADIYA.—*Continued.*

Station Nos. at extremity of each portion. (1)	Depth at Station. (2)	Length of portion on section line. (3)	Length of portion for Computation. (4)	Depth of portion for Computation. (5)	Observed flow of floats at Stations. (6)	Angle of flow of water for Computation. (7)	Mean time of passage of floats over Run at Stations. (8)	Mean time of passage for Computation. (9)	Multiplication. (10)	Area of portion. (11)	Discharge per second through portion. (12)
	Feet.	Feet.	Feet.	Feet.			Seconds.	Seconds.		Sup. Ft.	Cub. Ft.
66 to 67	9·25 6·75	150	147	8	220° 224°	$6\frac{1}{2}°$	10·5 14·5	12·5	$147 \times 8 \times \sec. 6\frac{1}{2}° \times \frac{50}{12\cdot5}$	1,176	4,734
67 to 64	6·75 4·00	141	141	5·3	224° 235°	....	14·5 15·0	14·75	$141 \times 5\cdot3 + \frac{50}{14\cdot75}$	747	2,533
64 to 65	4·0 3·75	247	240	3·5	235° 240°	10°	15·0 17·0	16·0	$240 + 3\cdot5 \times \sec. 10° \times \frac{50}{16\cdot0}$	840	2,665
65 to 70	3·75 5·25 midway 3·25	278	270	4	240° 240°	$12\frac{1}{2}°$	17·0 17·0	17·0	$270 \times 4 \times \sec. 12\frac{1}{2}° \times \frac{50}{17}$	1,080	3,254
70 to 71	3·25 1 midway 4·0	290	280	2	240° 243°	$13\frac{1}{2}°$	17·0 15·0	16·0	$280 \times 2 \times \sec. 13\frac{1}{2}° \times \frac{50}{16}$	560	1,800
71 to 69	4·0 4·25	78	76	4	243° 238°	12°	15·0 14·0	14·75	$76 \times 4 \times \sec. 12° \times \frac{50}{14\cdot75}$	304	1,054

69 to 72	4.25 5·50	230	227	4·8	238° 237°	9°	14·5 14·0	14·25	$227 \times 4{\cdot}8 \times \sec. 9° \times \frac{50}{14{\cdot}25}$	1,090	3,871
72 to 68	5·5 5·0	110	108	5·25	237° 235°	$7\frac{1}{2}°$	14·0 16·5	15·25	$108 \times 5{\cdot}25 \times \sec. 7\frac{1}{2}° \times \frac{50}{15{\cdot}25}$	567	1,875
68 to 73	5 5	176	174	4·75	235° 240°?	8°	16·5 15·0	15·8	$174 \times 4{\cdot}75 \times \sec. 8° \times \frac{50}{15{\cdot}8}$	827	2,641
73 to 74	5 5	210	208	5	240°? 225°	..	15·0 15·2	15·1	$208 \times 5 \times \frac{50}{15{\cdot}1}$	1,040	3,444
74 to 75	5 3·5	220	218	4·25	225° 227°	$2\frac{1}{2}°$	15·2 16·0	15·6	$218 \times 4{\cdot}25 \times \sec. 2\frac{1}{2}° \times \frac{50}{15{\cdot}6}$	927	2,972
75 to left bank	3·5 0	155	153	3·0	227°	..	16·0	20·0	$153 \times 3{\cdot}0 \times \frac{50}{20}$	459	1,148
									Totals,	16,396	66,251

Width of water 2790 feet. Mean velocity = 4 ft. per second.

For Discharge at ordinary High Flood add to the measured Discharge:—

width of portion in Feet.		depth.		velocity.		cubic ft. per second.
688	×	13	×	7	=	62,608
1,374	×	13	×	6	=	107,172
600	×	13	×	6	=	46,800
155	×	13	×	5	=	10,075
				Total,		226,655
			The measured Discharge,		=	66,251
			Total Discharge at ordinary high floods,		=	293,000

From this subtract flood discharge of Tengapáni and Noa Dihing Rivers, ... = 53,000

Flood discharge of Brahmaputra + Digáru rivers, ... = 240,000

Area of Flood section over measured section, ... = 36,721 S. Ft.
Add measured section, ... = 16,396

Area of Flood section, ... = 53,017 S. Ft. The mean velocity of Flood = 5·5 ft. per second.

Measured Discharge, ... = 66,251
Subtract volume of 3 ft. rise, ... = 32,419

Discharge of the Brahmaputra + Digáru + Noa Dihing + Tengapáni Rivers at their minimum level, ... = 33,832 The sectional area = 8,228 S. Ft. and mean velocity 4·1 ft. per second.

Subtract Noa Dihing + Tengapáni, their minimum discharge, ... = 3,000

30,800 Cubic feet is the minimum Discharge of Brahmaputra + Digáru rivers.

At time of measurement the river was 3 ft. above minimum level of the year, the increase in volume due to this rise is

105	×	3	×	5	=	1,575
143	×	3	×	5	=	2,145
285	×	3	×	5	=	4,275
150	×	3	×	5	=	2,250
140	×	3	×	4	=	1,680
240	×	3	×	3	=	2,160
76	×	3	×	4	=	912
227	×	3	×	3	=	2,724
108	×	3	×	4	=	1,296
600	×	3	×	4	=	7,200
						26,217

Add measured volumes of portions of section which are covered by the 3 ft. rise, 1,800; 1,148; 3,254

Total increase in volume, due to a 3 ft. rise above minimum level 32,419 cubic ft. per second.

H. J. Harman, Lt. R. E.,
Survey of India.

October, 1878.

III.—Hemiptera *from Upper Tenasserim.—By* W. L. Distant. *Communicated by* J. Wood-Mason.

(Received 22nd Feb. 1879; read 5th March, 1879.)

(With Plate II).

The following paper enumerates and describes the *Hemiptera* collected by Mr. Ossian Limborg in the district east of Moulmein, Tenasserim Provinces, and placed in my hands for determination by Mr. Wood-Mason, to whom the insects belong. So little has yet been done in enumerating the Hemipterous Faunas of the East, and this collection is so limited in extent, that it would be futile to attempt any elaborate scheme of tabulation in illustration of geographical affinities and distribution. The publication, however, of the details of such collections as this from a well specified neighbourhood will afford material for such work hereafter. Many of the species, as might be imagined, are common to Northern India, others range through the whole Eastern Archipelago as far as Celebes.

Heteroptera.

Fam. Pachycoridæ.

Chrysocoris grandis, Thunb.
C. porphyricolus, Walk.
Hotea curculionides, H. S.

Fam. Halydidæ.

Dalpada oculata, Fab.
D. varia, Dall.

Fam. Pentatomidæ.

Antestia anchora, Thunb.
Catacanthus incarnatus, Drury.
Prionaca lata, Dall.
Strachia crucigera, Hahn.

Fam. Edessidæ.

Cyclopelta obscura, St. F. and S.

Fam. Mictidæ.

Dalader acuticosta, A. and S.
Mictis tenebrosa, Fab.
M. gallina, Dall.
Physomelus calcar, Fab.
P. parvulus, Dall.

Fam. Homœoceridæ.

Homœocerus javanicus, Dall.
H. marginellus, H. S.

Fam. Anisoscelidæ.

Serinetha augur, Fab.
S. abdominalis, Fab.

Fam. Alydidæ.

Riptortus pedestris, Fab.

Fam. Coreidæ.

Acanthocoris scabrator, Fab.

Fam. Pyrrhocoridæ.

Lohita grandis, Gray.
Iphita limbata, Stäl.
Physopelta gutta, Burm.
Antilochus russus, Stäl.
A. coquebertii, Fab.
Odontopus nigricornis, Stäl.
Dindymus rubiginosus, Fab.
Dyodercus cingulatus, Fab.

Fam. Reduviidæ.

Euagoras plagiatus, Burm.
Velinus malayus, Stäl.
Reduvius mendicus, Stäl, var.
Vesbius sanguinosus, Stäl.

Fam. Aradidæ.

Brachyrhynchus membranaceus, Fab.

Fam. Acanthaspididæ.

Tiarodes versicolor, Lap.
Sminthus marginellus, n. sp.
Velitra rubro-picta, A. and S.

Fam. Gerridæ.

Ptilomera laticauda, Hard.
Limnogonus, sp. ?

Fam. Belostomidæ.

Belostoma indica, St. F. and S.

Homoptera.

Fam. Cicadidæ.

Platypleura nobilis, Germ.
P. insignis, n. sp.
Huechys sanguinea, De Géer.
H. philæmata, Fab.
H. thoracica, n. sp.
Scieroptera splendidula, Fab.
Dundubia mannifera, Linn.
D. intemerata, Walk.
Pomponia tigroides, Walk. var.
P. sp. ?
Cryptotympana recta, Walk.

Fam. Cercopidæ.

Cosmoscarta tricolor, St. F. and S. var.
C. megamera, Butl.
C. masoni, Dist.

Fam. Centrotidæ.

Centrotypus assamensis, Fairm.

Fam. Iassidæ.

Tettigonia ferruginea, Fab.

Fam. Eurybrachydidæ.

Eurybrachys (?) punctifera, Walk.
Ancyra appendiculata, White.

Fam. Ricaniidæ.

Ricania guttigera, Walk.

Fam. Flatidæ.

Cerynia maria, White. var.
tenella, Walk.

Notes and Descriptions.

Chrysocoris porphyricolus, Walk.

Call. porphyricola, Walk., Cat. Het., Part. I, p. 29, (1867).

Walker describes this form as being allied to *C. stockerus*, Linn. On the contrary it is very closely allied to *C. purpureus*, Hope, if not even a variety of that species.

Sminthus marginellus, n. sp. Pl. II, Fig. 1.

Sanguineous; head, elytra, lateral borders of sternum and abdomen beneath, and anal abdominal segment black. Antennæ obscure, testaceous; a sanguineous spot behind each eye and base of coriaceous portion of the elytra narrowly of the same colour.

Allied to *S. fuscipennis*, Stäl, from which it differs by the very much more robustly developed eyes and *the narrower space between them;* the head is also slightly more elongated, and the sculpture of the posterior lobe

of the pronotum is different. The colour of the head, extent of the basal coriaceous patch and the colour beneath also differentiates it.

Long. 18 mill.

Platypleura insignis, n. sp. Pl. II, Fig. 2.

Body testaceous, thickly covered with griseous pubescence, Pronotum, mesonotum and metanotum not differing in structure and markings from *P. nobilis*, Germ., but more pubescent; pectus, abdomen above and below also resembling that species. Rostrum with the tip pitchy, reaching a little beyond posterior coxæ. Legs pale ochraceous, fore and intermediate tarsi with the base, apex, and claws pitchy.

Tegmina pale hyaline, with the veins, membrana costæ, area costalis, area radialis (excepting almost apical half) and a large basal patch transversely terminated from near the apex of the lower side of the area radialis and the inner border of tegmina at apex of the lower of the areæ ulnares, fulvous covered with griseous pubescence. The area radialis is transparent hyaline from about its middle (where it is darker in colour) to near the apex, which is narrowly fulvous and has a subconical fuscous spot on its outer border. A row of small spots on outer margin of the areæ apicales, situated one on each side of the veins, a submarginal waved row of larger spots situated in like manner, and an irregular series of similar sized spots situated on the bases of the areæ apicales and apices of the areæ ulnares, black. The veins in some places are greenish. Wings pale hyaline, with the veins fulvous and a large black basal patch.

♂. Long. ex. tegm. 15 mill.; exp. tegm. 45 mill.

Allied to *P. nobilis*, Germ., but tegmina and wings very distinct, the opaque portion being much less than in that species. The rostrum is shorter in length and the drums do not overlap each other so much as in *P. nobilis*.

Huechys thoracica, n. sp. Pl. II, Fig. 3.

Black, pilose; pile griseous. Face sanguineous with a large triangular sub-basal black spot, transversely strigose and with a deep, central longitudinal impression. Antennæ testaceous with the basal joint black; eyes testaceous, more or less streaked with black (black in a second specimen I have seen). Ocelli, a triangular patch at base of head, the apex of which is situated between the ocelli, a central longitudinal hour-glass shaped fascia extending through whole length of pronotum, abdomen and three large spots on mesonotum, two lateral and one central, sanguineous. Pectus sanguineous with some frontal black markings. Rostrum and legs, black pilose. Tegmina opaque ochreous brown. Wings pale fuliginous hyaline with the nervures dark fuscous.

The rostrum reaches the apex of the intermediate coxæ.

♀. Long. ex. tegm. 19 mill.; exp. tegm. 43 mill.

Two other unnamed specimens of this species are in the British Museum from Hindustan.

Pomponia, sp.?

Owing to the number of insects described under the Genus *Dundubia*, frequently only one sex being known, I have considered it better to avoid describing this form until the other and allied genera are structurally monographed.

Cryptotympana recta, Walk. Pl II, Fig. 4.

Fidicina recta, Walk. Cat. Hom. I, p. 79, 1850.

Walker's type is a ♀, and I have therefore figured the underside of a ♂ in the collection, which seems to belong to this species. It is much paler in colouration above, being more olivaceous than black, but to this I attach no importance, nor do I to its smaller size. All the other characters agree The drums are olivaceous inwardly, broadly margined with black.

Long. ex. tegm. 32 mill.; exp. tegm. 95 mill.

Cosmoscarta tricolor, St. F. and Serv. Pl. II, Fig. 5.

Cercopis tricolor, St. F. and S. Enc. Méth. X, p. 604, 1827.

This only differs from the typical form in having the sub-basal fascia represented by a transverse waved series of four sanguineous spots; there is also a spot of the same colour at base. It is thus intermediate between *C. tricolor* and *C. basinotata*, Butl. with the last of which, before expanding the tegmina, I confused it. Butler's form differs also in the colouration of the abdomen. I have called this form a variety of *C. tricolor*, though the term "local race" would be more correct. The difference is certainly not "specific," using that definition in the ordinary sense.

Cosmoscarta Masoni, Dist. Pl. II, Fig. 6.

C. Masoni, Distant, J. A. S. B., 1878, Vol. XLVII, Pt. 2, p. 194.

Pronotum stramineous, with a quadrate black spot on anterior margin; head luteous; tegmina, pectus, legs and abdomen shining black. Prosternum with lateral borders stramineous.

Face robustly tumid, transversely strigose, with a central impunctate longitudinal impression; eyes prominent, luteous; ocelli distinct, shining, situated at about an equal distance from each other as from eyes; basal portion of the head somewhat pitchy. Pronotum thickly and finely punctured, with the lateral margins dilated and strongly reflexed, the lateral angles produced prominently outwards, and the posterior margin rounded, the disc is prominently raised and convex, across the centre of which is a faint impunctate central longitudinal line. The frontal quadrate black patch contains a deep, angular, linear impression on each side behind the eyes, and two small rounded impressions on the posterior border.

Tegmina obscurely and finely punctured; wings dark fuscous with the nervures black. Hind tibiæ with a small spine towards apex.

♀. Long. ex. tegm. 17 mill. Exp. tegm. 45 mill.

Greatest long. pronot. 7½ mill. Exp. lat. ang. pronot. 11 mill.

Habitat, Taoo, Tenasserim. Alt. 3—5000 ft.

Explanation of Plate II.

Fig. 1. *Sminthus marginellus*, Dist.
„ 2. *Platypleura insignis*, Dist.
„ 3. *Huechys thoracica*, Dist.
„ 4. *Cryptotympana recta*, Walk.
„ 5. *Cosmoscarta tricolor*, St. F. and S. var.
„ 6. „ *masoni*, Dist.

IV.—*On the Diurnal Variation of Rainfall Frequency at Calcutta.*—*By* Henry F. Blanford, F. G. S., F. Z. S., F. M. S.

(With Plate III.)

[The greater part of the following paper was written some months since in France, and laid before the Society at its meeting in November 1878. In the original paper, the registers of only six years were discussed; but inasmuch as those for twenty years are available in the Meteorological Office, on my return to India, with the permission of the Council, I have withdrawn and recast the paper, including in the data the whole of the existing registers. As might have been anticipated, the inclusion of a period more than three times as long as that originally treated of, has had the result of clearing away some irregularities, and of bringing out more distinctly the true character of the variation; some of the minor features of which were but doubtfully indicated in the original restricted table; while the more prominent features have been confirmed and emphasised. With a view to their more ready appreciation, a plate has been added, which will enable the reader to compare the diurnal variation of rain frequency at different seasons, with the normal diurnal variations of pressure, temperature, relative humidity and vapour tension at Calcutta. H. F. B.]

The tables here summarised are based on the hourly observations recorded at the Surveyor General's Office from August 1856, to March 1877*; during the greater part of the period on the autographic traces of an Osler's anemometer. The form of the reduction does not show the quantity of the rainfall, but only the fact of its occurrence at the several hours specified; in other words, its comparative frequency; and it is possible that the two kinds of variation may not strictly coincide. The traces in question have not yet been reduced for quantity, otherwise than for the total diurnal fall; but the laws of diurnal variation in point of frequency are so salient and decided, that it is hardly likely that any conclusions to which they may lead,

* As published in the Society's Journal.

bearing on the causes that determine precipitation will require serious modification, when the quantity of precipitation is also taken into account. This investigation, I hope to enter upon when the completion of other more pressing matters shall allow of my taking up the enquiry. Meanwhile, the present will, I think, be found a not unimportant contribution to Meteorological Science.

Table showing the Number of Hours in which rain was recorded during 21 *years at Calcutta.*

HOURS A. M.

	Midn. to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to Noon.	Midn. to Noon.
January, ...	3	3	5	8	9	8	8	7	8	8	11	10	88
February, ...	9	9	14	10	11	7	9	12	9	6	13	6	115
March, ...	7	9	11	8	4	5	7	9	9	11	6	8	94
April, ...	9	6	7	8	5	5	7	5	5	6	5	5	73
May, ...	12	14	14	12	12	14	14	11	10	13	18	20	164
June, ...	65	68	64	55	70	70	73	75	63	81	88	95	867
July, ...	80	92	94	88	82	95	88	97	102	114	121	135	1188
August, ...	97	94	94	112	107	109	105	102	103	107	124	133	1287
September, ...	36	47	65	64	68	57	65	55	48	72	83	86	746
October, ...	20	26	31	34	37	45	42	44	41	36	42	56	454
November, ...	2	3	6	8	6	8	8	8	8	6	10	9	82
December, ...	3	3	4	3	3	3	4	1	3	1	1	2	31
Yearly Total, ..	343	374	409	410	414	426	430	426	409	461	522	565	3189

HOURS P. M.

	Noon to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23	23 to Midn.	Noon to Midn.
January, ...	5	5	6	6	11	9	6	4	5	5	4	6	72
February, ...	7	9	7	13	9	9	10	13	8	10	9	8	112
March, ...	6	7	9	18	18	23	23	28	22	14	12	9	184
April, ...	7	5	11	25	25	26	24	33	30	23	11	9	229
May, ...	23	26	27	23	31	53	52	64	57	44	38	16	454
June,..	101	89	96	74	83	86	88	86	85	67	66	59	980
July, ...	152	150	140	119	118	103	100	93	85	56	65	60	1241
August, ...	126	140	142	119	109	112	91	70	71	77	81	84	1222
September, ...	107	103	130	116	107	80	80	64	49	36	44	35	951
October, ...	57	55	64	49	47	32	38	30	31	25	26	25	479
November, ...	11	10	11	7	8	9	7	7	4	4	4	6	88
December, ...	1	1	3	2	5	2	2	3	2	0	0	2	23
Yearly Total, ..	603	600	646	571	566	544	521	495	449	361	360	319	6035

From this table, the following conclusions may be drawn. On the average of the year, which average is mainly determined by that of the summer monsoon months, the hour at which rain is least frequent is shortly before midnight, and that at which it is most so, from 2 to 3 P. M. The latter accords approximately with the diurnal epoch of maximum temperature [see Plate III, fig. 6], but the former does not accord with its minimum; and, indeed, the frequency of rain at the hour of mean minimum temperature is nearly 40 per cent. greater than at midnight, while at the hour of its maximum it is only twice as great; and it would rather appear that while the greatest heat coincides with a principal maximum of rainfall, the greatest cold coincides with a secondary maximum. The course of variation as shewn by the table and by fig. 1 of the plate is somewhat as follows:

For about three hours after midnight, the frequency of rainfall increases rapidly, but after 3 A. M. more slowly, till about sunrise; after which there is a slight falling off to a secondary minimum at 9 A. M. This is very distinctly shown in the present table: in that originally drawn up it was less clearly indicated. After 9 A M. the frequency increases rapidly to the absolute maximum between 2 and 3 P. M. From this maximum it declines, without interruption, to the minimum before midnight. The total number of rainy hours from midnight to noon is 46 per cent. of the whole; and between noon and midnight 54 per cent. On the other hand, in the day time (6 A. M. to 6 P. M.), the proportion is 57 per cent., and 43 per cent. in the night hours.

The character of the variation in the rainy months of the summer monsoon does not differ materially from the above. But that of the hot season is very different; and that of the cold season again differs from both and is more uniform than either. The following table and figs. 2, 3 and 4 in the Plate exhibit the data thus arranged according to the three seasons.

	Hours A. M.											
	Midn. to 1	1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to Noon
Rains: June to October,	298	327	348	353	364	376	373	373	357	410	458	505
Hot season: March to May, ...	28	29	32	28	21	24	28	25	24	30	29	33
Cold season: November to February, ...	17	18	29	29	29	26	29	28	28	21	34	27

	Hours p. m.											
	Noon to 13	13 to 14	14 to 15	15 to 16	16 to 17	17 to 18	18 to 19	19 to 20	20 to 21	21 to 22	22 to 23	23 to Midn.
Rains: June to October,	543	537	572	477	464	413	397	343	321	261	282	263
Hot season: March to May, ...	36	38	47	66	69	102	99	125	109	81	61	34
Cold season: November to February, ...	24	25	27	28	33	29	25	27	19	19	17	22

The variation in the rainy months is, then, almost identical with that above described, the chief difference being that after the afternoon maximum, the decline is more rapid. The heavy rains of the monsoon months are, then, more particularly rains of the day time, favoured and accelerated by the diurnal rise of temperature, and declining with the decline of the sun's heat. In a nearly saturated atmosphere, the rapidity with which vapour ascends from lower to higher levels, and eventually becomes dynamically cooled and condensed, depends on the temperature, increasing indeed as the square of the absolute temperature. The relative humidity of the lower atmosphere (as tested in our observations), does not follow the same course of variation. Indeed, as may be seen in fig. 7, this course is exactly the inverse of that of temperature, but as far as can be judged from casual observation, the formation and dispersion of *cumulus* cloud, indicating the state of saturation at heights of from 2000 to 7000 or 8000 feet, is equally determined by the rise and fall of the temperature, and in its mode of formation the rain-cloud of the summer monsoon is essentially *cumulus*. The hour of least frequent rainfall, which in the summer monsoon would seem to be between 10 and 11 p. m., is probably also that of least cloudiness. The horary variation of cloud is not known for Calcutta, but I found some time since on examining the registers of a number of Bengal stations, at which the cloud proportion had been recorded for some years at 4 and 10 a. m. and p. m. that the average at 10 p. m. was very considerably below that observed at other hours. Kreil has noticed a similar fact at Vienna, and Neumayer in his discussion of the Observations of the Flag-Staff Observatory at Melbourne, also finds that, on the average of the year, there is a strongly marked minimum about this hour. Kreil explains this tendency to the dispersion of cloud, after sunset, by the compression which the lower atmospheric strata undergo, in consequence of the general contraction and subsidence of the mass; to which action he also refers the coincident baro-

metric rise and maximum. In any case, this coincidence of minimum raininess, minimum cloudiness and the semi-diurnal maximum of pressure, is an important fact of observation.

The rapid rise of rain-frequency after midnight corresponds, though less exactly, to the nocturnal fall of pressure; but, as on the average of the year, the secondary maximum is not reached till some time after sunrise, *viz.*, about 6 A. M. In the Melbourne curve of cloud variation, this is also about the epoch of the diurnal maximum, and as already remarked it is that of minimum temperature and maximum humidity at the ground surface. The slight fall that ensues continues till between 8 and 9, which is about an hour in advance of the epoch of maximum pressure. It would seem therefore that the tendency to the precipitation of rain is a somewhat complex function of the temperature and pressure variations; or inasmuch as the latter is an effect of the former, of the temperature variation producing two conditions which are in part mutually antagonistic in their effect on the rainfall. To sum up the results of this discussion, I would suggest the following as a possible explanation of the rainfall variation. The cooling of the atmosphere after 3 P. M. in the first place checks the production and ascent of vapour, as well as of convective atmospheric currents, and (adopting Kreil's explanation of the barometric tides) causes a rise of pressure in the lower atmosphere as a consequence of the sinking and compression of the atmospheric mass. These effects bring about a dispersion of cloud and a fall of rainfall frequency from the absolute maximum to the absolute minimum of the 24 hours. About 10 P. M. the compression having reached its maximum, re-expansion sets in, and, in conjunction with continued cooling, raises the relative humidity of the cloud-forming strata, and consequently the tendency to the formation of cloud and rain. When the re-expansion ceases about 3 or 4 A. M., the loss of heat is still operative in the same direction, though less powerfully; but, after sunrise, the direct effect of the solar heat is to diminish cloud and rainfall, while raising the pressure of the lower atmosphere; and it is not until this increasing pressure has nearly attained its maximum, and the ascent of vapour has become sufficiently active to prevail over these first effects, that the formation of cloud* and rainfall proceed actively, and attain their afternoon maximum; this condition coinciding with the highest temperature and the greatest activity of diffusing vapour and convective currents.

This explanation, I must remark, is suggested solely by a consideration of the several coincident phenomena, and presupposes an atmosphere highly charged with vapour, such as is that of the summer monsoon. It would be impossible to predict the course of the changes *a priori*, because the several

* This is of course an assumption as regards the cloud maximum.

actions being to a certain extent mutually antagonistic in their effects on the formation of rain, it would be impossible to foretell, in the absence of direct observations made in the cloud-forming strata, when and how these effects would mutually balance, and in what measure and at what epochs one or the other would become predominant.

In the dry and hot season the diurnal course of rainfall variation is very different from the above. The diurnal epoch of minimum is not very distinctly indicated, but would appear to fall about sunrise. There is, however, but little variation from midnight up to 9 or 10 A. M.; and after this only a slow rise up to 2 P. M., when the increase becomes more rapid. About two hours before sunset there is a sudden rise of about 50 per cent., and the hour of maximum raininess occurs between 7 and 8 P. M., the number of recorded falls being then six times as great as at sunrise. This very striking feature of the hot season is due to the well-known evening storms, commonly called *North-Westers*, which are closely analogous to the thunderstorms of the European summer; and, whether as rain or hail-storms or simply as dust-storms, are characteristic of the dry season more or less in all parts of India. In Lower Bengal they are especially frequent, and the favouring conditions appear to be, the presence of a certain moderate supply of vapour brought by the coast winds, a high temperature at and near the ground surface, and a dry westerly wind from the interior of the country, which in Lower Bengal blows chiefly as an upper current from the plateau of Western Bengal, but during the hottest hours of the day, when it is at its greatest strength, produces a marked effect on the mean wind direction at Calcutta, and is sometimes felt there directly as a hot surface wind. It is when this wind slackens towards sunset, and that from the direction of the coast gains in prevalence, producing a calm in the interval, that North-Westers chiefly occur. They receive their name from the fact that the storm-cloud most commonly originates in the North-West, and advances or rather forms up with great rapidity from that direction, the formation of the nimbus overhead being speedily followed by violent gusts of wind from the same direction, which raise clouds of dust and occasionally exert pressures comparable with those of a cyclone. Immediately before the onset of the storm, the barometer rises rapidly, sometimes more than 0·1 inch; and, as Mr. Eliot has shown from a study of the autographic records of the Alipore Observatory, the subsequent fall coincides with the onset of the stormy winds, and a great and sudden fall of temperature and vapour pressure. Frequent casual observations of the motion of the dust and cloud margin in advance of these storms, have led me to conclude that the stormy wind which blows out from under the storm-cloud is a great horizontal eddy, the impulse of which is furnished by the air dragged down,

partly by the friction of the rain. But this is not invariably the case; as I have more than once experienced a gusty though less violent wind, when no rain was falling. The only essential feature, which is apparently common to all storms of this class, including the dry and rainless dust-storms of the Punjab and hail-storms, is a more or less spasmodic and sudden subversion of vertical equilibrium, and rapid convection accompanied by eddying currents, and generally, in Bengal, at least, by heavy rain. It is somewhat remarkable that their most frequent occurrence coincides with the most rapid cooling of the atmosphere, but it must be observed that as a general, if not invariable, rule the cloud canopy in which the storm originates has been formed during the day, and that this shields the subjacent air and earth surface from rapid cooling, while the higher strata are radiating freely into space.

Lastly, in the cold season, falls of rain are distributed pretty evenly throughout the day, with a decided diminution during the two or three hours before and after midnight; as shown in the table, from 8 P. M. to 2 A. M. This period corresponds with that of the strongly marked minimum of the rainy season; and may probably be referred to similar causes; the atmosphere of the cold weather being normally of higher humidity than that of the hot season, and especially when a southerly wind sets in, which is always the precursor of rain.

The general conclusion to be drawn from this discussion is, that the conditions which promote and determine precipitation, are different at different seasons. In the highly vapour-charged atmosphere of the rainy monsoon, and in a much less degree in the cold season, condensation is most promoted by increasing temperature, and the more active ascent of vapour determined thereby. In a minor degree, the opposite action, *viz.*, nocturnal cooling, under certain conditions, produces the same effect, but this is complicated with those of the internal movements (the compression and expansion) of the atmosphere, which are another effect of the oscillation of temperature. In the comparatively dry atmosphere of the hot weather, the precipitation is chiefly that of storms, which are spasmodic movements, arising from the subverted equilibrium of the superimposed strata; and these are most frequent when the atmosphere as a whole is cooling most rapidly. They are probably the effect of unequal cooling.

V.—*Record of the Occurrence of Earthquakes in Assam during*

Date.	District.	Time of occurrence.	Duration.
19th Jan. 1878.	Darrang, Tezpur.	12.50 A. M.	From 8 to 12 seconds.

Ascertained that this shock was not felt in the following districts: Cachar, Goalpára and

Date.	District.	Time of occurrence.	Duration.
3rd Feb. 1878.	Darrang, Tezpur.	11.52 P. M.	5 to 8 seconds.

Ascertained that this shock was not felt in the following districts: Cachar, Lakhimpur and

Date.	District.	Time of occurrence.	Duration.
5th Feb. 1878.	Darrang, Tezpur.	1 P. M.	Each shock from 10 to 15 seconds.
Do.	Do.	7.15 P. M.	
Do.	Do.	10.40 P. M.	
Do.	Goalpára.	7.10 P. M.	About 30 or 35 seconds.
Do.	Do.	11.30 P. M.	About 40 seconds.
Do.	Shillong, (Khási and Jaintea Hills).	7.18 P. M.	About 10 seconds.
Do.	Do.	10.30 P. M.	Do.
Do.	Gauháti, (Kamrúp).	7.15 P. M.	5 seconds.
Do.	Do.	10.45 P. M. or there abouts.	3 seconds.
Do.	Turá (Gáro Hills).	7.30 P. M.	About 20 seconds.
Do.	Do.	10.15 P. M.	About 10 seconds.
Do.	Barpeta (Kamrúp).	7.30 P. M.	Not given.
Do.	Do.	11 P. M.	Do.
Do.	(Goalpára), Dhúbri.	7.30 P. M.	About 5 seconds.
Do.	Do.	10.40 P. M.	About 3 seconds.
Do.	Nowgong.	7.30 P. M.	About 10 seconds.
Do.	Do.	10.5 P. M.	About 5 seconds.
Do.	Cachar.	7.50 P. M.	About 2 seconds.
Do.	Do.	11·50 P. M.	About 1 second.

N. B. It was not felt in the Nága Hills, Lakhimpur and Sibságar

1878.—*Communicated by the* Chief Commissioner of Assam.

Apparent direction.	Extent of damage, if any, and general Remarks.
Not noticed.	A smart shock; preceded by the usual rumbling noise. No damage done.
Sylhet, Nowgong, Khási Hills, Gáro Hills, Lakhimpur, Sibságar, Nága Hills, Kamrúp.	
N. Westerly direction.	The rumbling noise that preceded the shock was very loud and distinct. The shock itself, slight. No damage done.
Sylhet, Nowgong, Khási Hills, Gáro Hills.	
Sibságar.	
Not noticed.	No damage done. The shocks were slight but the rumblings that preceded each shock were unusually loud and prolonged.
S. to N.	The second was somewhat heavier than the first. No damage done.
Do.	
W. to E.	No damage done. Both smart shocks.
Do.	
W. to E.	There were two sharp shocks but no damage done.
Do.	One shock. No damage done.
W. to E.	No damage done.
W. to E.	No damage done.
N. to E.	
Not stated.	
N. E. to S. W.	Two smart shocks were felt.
Do.	Only one shock, which passed very soon.
N. W. to S. E.	One sharp shock. No damage.
Do.	No damage.
N. to S.	A slight shock.
Do.	A very slight shock.

Districts. It was felt in Sylhet, necessary particulars were not noted.

Date.	District.	Time of occurrence.	Duration.
25th Feb. 1878.	Nowgong.	7.30 P. M.	3 seconds.
Do.	Shillong, (Khási Hills).	8.20 P. M.	3 seconds.
Do.	Cachár.	8.30 P. M.	1 second.
Do.	Goalpára.	9 P. M.	1 second.
Ascertained this shock was not felt in the district of Kamrúp,			
13th April, 1878.	Nowgong.	9.30 P. M.	5 seconds.
Do.	Shillong, (Khási Hills).	10.45 P. M.	5 seconds.
Do.	Gauháti, (Kamrúp).	10.5 P. M.	a few seconds.
Do.	Tezpur, (Darrang).	10.50 P. M.	8 to 10 seconds.
Ascertained that this shock was not felt in the following districts :			
19th April, 1878.	Jorehát sub-division of Sibságar.	9 P. M.	1 minute.
Ascertained that this shock was not felt in the following districts : Sylhet, Khási Hills and			
23rd April, 1878.	Jorehat sub-division of Sibsagar.	4.30 P. M.	10 seconds.
Not felt in the following districts : Sylhet, Cachár, Goalpára, Gáro Hills,			
29th April, 1878.	Samaguting, NágaHills.	1.30 P. M.	5 seconds.
Do.	Nowgong.	2.30 P. M.	5 seconds.
Do.	Shillong, (Khási Hills).	2.37 P. M.	30 seconds.
Do.	Darrang, Camp Urung.	2.40 P. M.	8 to 10 seconds.
Do.	Sibságar, (Head Qrs.)	2.50 P. M.	Less than 1 second.
Do.	Lakhimpur, Dibrughar.	2.51 P. M.	3 to 4 seconds.
Do.	Kamrúp, Gauháti.	3 P. M.	A few seconds.
Do.	Golaghát sub-division of Sibságar.	Noon.	Not noticed.
Do.	Jorehát sub-division of Sibságar.	Not noticed.	10 seconds.
Ascertained that this shock was not felt in the following			
2nd May, 1878.	Shillong, (Khási Hills).	2.30 A. M.	About 10 seconds.
Do.	Nowgong.	Night.	Not noticed.
Not felt in the following districts : Sylhet, Cachár, Goalpára, Gáro			
4th May, 1878.	Nowgong.	12 P. M.	About 5 seconds.
Do.	Tezpur, (Darrang).	1 A. M.	12 to 15 seconds.
Do.	Shillong, (Khasi Hills).	2.20 P. M.	3 seconds.
Ascertained that this shock was not felt in the following districts : Sylhet,			

Apparent direction.	Extent of damage if any and general Remarks.
N. W. to S. E.	No damage.
W. to E.	No damage.
N. W. to S. E.	One smart shock. No damage.
S. to N.	No damage.
Sibságar, Nága Hills, Sylhet, Lakhimpur, Darrang and Gáro Hills.	
N. W. to S. E.	No damage.
W. to E.	Do.
W. to E.	One smart shock. No damage.
Not noticed.	Two distinct and very smart shocks in rapid succession. No damage.
Cachár, Goalpára, Gáro Hills, Sylhet, Sibságar, Nága Hills, and Lakhimpur.	
S. W. to N. E.	No damage.
Cachár, Goalpára, Gáro Hills, Kamrúp, Darrang, Nowgong, Lakhimpur. Nága Hills.	
Not noticed.	No damage.
Kamrúp, Darrang, Nowgong, Lakhimpur, Khási Hills and Nága Hills.	
W. to E.	No damage.
S. to N.	A very slight shock. No damage.
W. to E.	No damage.
Not noticed.	Two very clear smart and distinct shocks felt. They were also felt at Mangaldai. No damage done. The usual rumbling noise did not precede these shocks.
N. to S.	No damage.
N. to E.	No damage. Slight shock ; weather rather sultry.
W. to E.	A slight shock. No damage.
E. to N.	No damage.
Not noticed.	No damage.
districts : Sylhet, Cachár, Goalpára and Gáro Hills.	
S. to N.	No damage.
Not noticed.	Do.
Hills, Kámrúp, Darrang, Sibságar, Lakhimpur and Nága Hills.	
N. W. to S. E.	No damage.
S. E. to N. W.	Two very smart shocks preceded by the usual rumbling noise ; no damage.
S. to N.	No damage.
Cachár, Goalpára, Gáro Hills, Kamrúp, Sibsagar, Lakhimpur and Nága Hills.	

Date.	District.	Time of occurrence.	Duration.
13th May, 1878.	Shillong, (Khási Hills).	10 A. M.	4 seconds.

Not felt in the following districts: Sylhet, Cachár, Goalpára, Gáro Hills,

30th May, 1878.	Shillong, (Khási Hills).	10 P. M.	About 5 seconds.

Not felt in the following districts: Sylhet, Cachár, Goalpára, Gáro Hills,

2nd June, 1878.	Shillong, (Khási Hills).	10.25 P. M.	About 5 seconds.

Not felt in the following districts: Sylhet, Cachár, Goalpára, Gáro Hills,

1st July, 1878.	Shillong, (Khási Hills).	4 P. M.	About 10 seconds.

No report from other districts; apparently

2nd July, 1878.	Tezpur, (Darrang).	6.15 A. M.	5 seconds.
Do.	Gauháti (Kámrúp).	6.26 A. M.	6 seconds.
Do.	Sibságar, } Sibságar.	6.4 A. M.	3 seconds.
Do.	Jorehát, } Sibságar.	7 A. M.	20 seconds.
Do.	Nowgong.	6 P. M.	5 seconds.
Do.	Samagúting, (Nágá Hills).	6.10 P. M.	10 seconds.

Ascertained that the shock was not felt in Lakhimpur,

5th July, 1878.	Shillong, (Khási Hills).	8.20 A. M.	About 5 seconds.
Do.	Tezpur, (Darrang).	8.20 A. M.	A few seconds.
Do.	Gauháti, (Kámrúp).	8.33 A. M.	About 20 seconds.
Do.	Nowgong.	About 8 P. M.	About 2 seconds.

Not felt in Goalpára, Gáro Hills, Sylhet,

31st July, 1878.	Shillong, (Khási Hills).	10.20 A. M.	A second or two.

Ascertained that the shock was not felt in Goalpára, Kámrúp, Nowgong,

Apparent direction.	Extent of damage if any and general Remarks.
S. to N.	No damage.
Kámrúp, Darrang, Nowgong, Sibságar, Lakhimpur and Nága Hills.	
N. to S.	No damage.
Kámrúp, Darrang, Nowgong, Sibságar, Lakhimpur and Nága Hills.	
N. to S.	Very slight shock. No damage.
Kámrúp, Darrang, Nowgong, Sibságar, Lakhimpur and Nága Hills.	
S. to N.	No damage done.
not felt anywhere in the Province.	
N. W. to S. E.	No damage, two successive shocks perceptible, but both slight.
N. E. to S. E.	No damage done.
Not known.	No damage.
E. to W.	No damage.
N. W. to S. E.	No damage done.
E. to W.	No damage.
Gáro Hills, Cachár, Sylhet, and Khási Hills.	
W. to E.	No damage done.
Not observed.	No damage, three distinct shocks. The centre one most severe, loud rumbling noise preceded the shocks.
N. E. to S. W.	One smart shock. No damage to property.
N. E. to S. W.	A very slight shock. No damage done.
Cachár, Lakhimpur, Sibságar and Nága Hills.	
S. W. to N. E.	No damage done.
Darrang, Sibságar, Lakhimpur, Gáro Hills, Nága Hills, Sylhet and Cachár.	

Date.	District.	Time of occurrence.	Duration.
4th Augt. 1878.	Tezpur, (Darrang).	8 A. M.	2 seconds.
		No reports received from	
30th Augt. 1878.	Tezpur, (Darrang).	6.8 P. M.	A few seconds.
			No reports received
3rd Oct. 1878.	Jorehát, Sibságar.	About 2 P. M.	About ½ a minute.
			Not felt in
13th Nov. 1878.	Shillong, (Khási Hills).	4.30 A. M.	About 5 seconds.
Do.	Nowgong.	About 4.30 A. M.	About 3 seconds.
Do.	Gauhâti, (Kámrúp).	About 5 A. M.	4 to 5 seconds.
Do.	Sylhet.	5.30 A. M.	2 seconds.
Do.	Tezpur, (Darrang).	5.30 A. M.	A few seconds.
	Ascertained that this shock was not felt at Goalpára,		
14th Nov. 1878.	Shillong, (Khási Hills.)	12.20 A. M.	About 15 seconds.
Ascertained that the shock was not felt at Goalpára, Kámrúp, Darrang,			
29th Nov. 1878.	Tezpur, (Darrang).	5 A. M.	5 to 8 seconds.
	Not felt at Goalpára, Kámrúp, Nowgong, Sibságar, Lakhimpur,		
1st Dec. 1878.	Shillong, (Khási Hills).	6¼ P. M.	About 5 seconds.
	Not felt at Goalpára, Kámrúp, Darrang, Nowgong, Sibságar,		
8th Dec. 1879.	Shillong, (Khási Hills).	11.30 P. M.	About 5 seconds.
	Not felt in Kámrúp, Darrang, Nowgong, Sibságar, Lakhimpur,		
25th Dec. 1878.	Tezpur, (Darrang).	12.42 P. M.	A few seconds.
Not felt in Goalpára, Kámrúp, Darrang, Nowgong, Sibságar, Lakhimpur,			

Apparent direction.	Extent of damage if any and general Remarks.
N. to S.	No damage.
the other districts.	
From N. E.	Two shocks, preceded and succeeded by a loud rumbling.
from other districts.	
W. to E.	Nil.
other districts.	
W. to E.	No damage done.
N. W. to S. E.	Do., a very slight shock.
S. E. to N. W.	One shock, no injury done.
E. to W.	No damage.
Not noticed.	Very distinct and marked while it lasted. No damage done.
Sibságar, Lakhimpur, Cachár, Garo Hills and Nága Hills.	
N. to S.	No damage done.
Nowgong, Sibságar, Lakhimpur, Cachár, Sylhet, Nága Hills and Gáro Hills.	
Not noticed.	No damage done. The actual shock was slight but the rumbling and noise preceding the shock was unusually loud and marked.
Cachár, Sylhet, Naga Hills, Gáro Hills and Khási and Jaintia Hills.	
W. to E.	No damage done.
Lakhimpur, Cachár, Sylhet, Gáro Hills and Nága Hills.	
S. to N.	No damage done.
Goalpára, Cachár, Sylhet, Gáro Hills and Nága Hills.	
Not observable.	A very slight shock.
Cachár, Sylhet, Gáro Hills, Khási and Jaintia Hills and Nága Hills.	

VI.—*On some experiments made at H. M.'s Mint in Calcutta on coining Silver into Rupees.—By* Col. J. F. Tennant, R. E., F. R. S., &c., *Master of the Mint.*

(Received 22nd March;—Read 2nd April, 1879.)

It has long been known that when an alligation containing fine silver and copper has been melted the result is an apparent refining, and the result of the further processes in coining is also to change the constitution of the alloy. In order, therefore, to produce Rupees of standard weight and fineness, it has always been found necessary to allow for these changes. The rule by which this allowance was made, however, did not seem to me to have any good foundation, and, while generally speaking the results were fair, there were occasional departures which convinced me that it could be improved. The rule here has been to make the alligation to standard $\frac{11}{12}$ of silver: scissel being assumed to have this fineness—then copper was added in proportion to all the silver except scissel, so as to reduce the fineness and this "extra alloy" was subject to variation on different coins.

It was clear then that silver in the form of scissel was not supposed to refine, and next that the whole of the change was not supposed to occur in melting, but partly to depend on the further processes. The last was a matter which was evidently more than probable; and as regards the first Col. J. T. Smith, late Master of this Mint, had many years ago shown that after a time a silver alloy ceased to refine. It seemed to me more than probable that this last result was only an approximation to the truth, and that the fact was that copper when mixed (at all events in small quantities) with silver was not exposed to oxidation in the furnace; but on this hypothesis it became absurd to add extra alloy on silver of 900 milliémes of fineness as on fine bars. I thought too that I saw that the variations which such an error would cause really took place, and resolved therefore to investigate the whole matter experimentally.

Silver at this Mint is reported to 0·2 of a milliéme: when an alligation is made, it is usually arranged that there shall not be a great number of finenesses used, and as each quality will be composed of several samples, these are all mixed in a heap, so that the silver used is the average (roughly) of several samples all reported alike. This procedure generally allows all the pots of a day's melting to be practically identical in fineness and weight, and if this be not the case it is very rarely that there are not several similar pots. There were no cases of single pots in this work, though owing to a small stock of silver, the whole in each melting could not be made alike.

Having the weight and fineness of each sample of silver in a pot, we are in a position to compute its fineness on the supposition that no change takes place in melting: this I call the "*Theoretical Fineness.*" When the contents are melted and well mixed, a small spoonful of the fused alloy is granulated and from this a muster is delivered to the Assay Master: the fineness of this I have called the "*Fineness of Pot,*" it is generally greater than the Theoretical fineness. In the later processes and especially in that of "pickling," preparatory to coining, the fineness is further increased, and the final result is determined from an assay of the coins by taking a proportion of coins for assay singly, and also some for assay after melting them up. This last determination is the least satisfactory; however uniform the melted mixture may be, the alloy is not equally distributed in the resultant ingots and every after process tends to increase this irregularity; so that at last, not only are the various coins different in their fineness, but portions taken from different parts of the same coin are so. I have used as a measure of the fineness of the coins of one day, the mean result derived from 20 single coins—the sample piece being always cut out from the centre of the coin, and I have called the result "*Fineness of Coins.*"

During these experiments 10 pots were daily alligated to the same *Theoretical Fineness*: I have thus had a measure of the accuracy of the Assay Reports, and I have used this for calculating the probable errors of the theoretical finenesses, in a way which (though somewhat arbitrary) seems to me sufficiently accurate for the purpose. When the probable error of an Assay Report is known, it is easy to calculate that of one heap, made of several samples of one quality, on the supposition that the whole is fairly mixed. As, however, the mixture must at best be very imperfect, I have preferred assigning to each quality of silver the same probable error of fineness as though all had depended on a single report.

As any erroneous hypothesis as to the quality of scissel used would clearly have vitiated the results, I had a quantity melted down, assayed, and laminated, each pot being kept separate, and thus I had metal which was of known fineness—save the small change from lamination which would equally be shared by all scissel—but which I conceived would be subject in melting to the same changes as scissel itself.

I had intended to keep the work from each pot separate all through, but after a certain point this was found impracticable, and the coins from a single day's melting have been mixed. After I had completed the greater part of the calculation for this paper, I found that, by a careless blunder, there had been a mixing of the coins of the second and third days' meltings: and though I could only prove that it had been slight, and it probably would not have seriously affected the result, I had the work of those days repeated and I use this repetition, though the results are not nearly so accordant as

those I first had. This is the reason why the melting numbers do not run continuously from 89 to 98; 90 and 91 being omitted and 114 and 115 inserted.

The following table shows the mean results for each day's work with their probable errors; the quantities of scissel and copper used daily are approximately shown. The unit of weight is a tolah of 180 English grains. A pot contains close on 12,500 tolahs, or 4687.5 ounces troy, and the whole quantity of standard silver melted and watched was about 12,45,000 tolahs, or 466,875 ounces troy, or about 14,521 kilograms. What is not accounted for as scissel or copper was refined bar silver of about 997 fine. The scissel was about 916 fine.

Melting No.	Composition.	Fineness in millièmes			Gain in fineness.		
		Theoretical.	of Pots.	of Coins.	Pots — Theory.	Coins — Theory.	Coins — Pots.
97	All scissel, No copper,	915·80 ±0·078	915·82 ±0·041	916·34 ±0·080	0·02 ±0·088	0·54 ±0·112	0·52 ±0·090
98	All scissel, No copper,	915·80 ±0·058	915·63 ±0·038	916·35 ±0·089	—0·17 ±0·069	0·55 ±0·106	0·72 ±0·097
89	9563 scissel, 186 copper,	916·47 ±0·079	916·83 ±0·032	917·40 ±0·086	0·16 ±0·086	0·73 ±0·117	0·57 ±0·092
115	10100 scissel, 189 copper,	916·42 ±0·049	914·36 ±0·027	917·30 ±0·085	—0·06 ±0·056	0·88 ±0·098	0·94 ±0·089
114	7529 scissel, 404 copper,	916·19 ±0·057	916·75 ±0·018	917·05 ±0·078	0·56 ±0·060	0·86 ±0·097	0·30 ±0·080
92	7512 scissel, 407 copper,	916·20 ±0·069	916·31 ±0·019	916·89 ±0·093	0·11 ±0·072	0·69 ±0·116	0·58 ±0·095
93	5002 scissel, 611 copper,	915·96 ±0·066	916·72 ±0·022	917·07 ±0·041	0·76 ±0·070	1·11 ±0·078	0·35 ±0·047
94	5004 scissel, 609 copper,	915·95 ±0·066	916·80 ±0·032	917·20 ±0·077	0·85 ±0·073	1·25 ±0·101	0·40 ±0·083
95	2501 scissel, 826 copper,	915·71 ±0·074	916·05 ±0·018	916·87 ±0·080	0·34 ±0·076	1·16 ±0·109	0·82 ±0·082
96	2523 scissel, 816 copper,	915·72 ±0·074	916·65 ±0·029	917·28 ±0·097	0·93 ±0·079	1·56 ±0·122	0·63 ±0·101

It will be seen that two meltings have been made for each proportion of copper. If C represent roughly one hundred tolas of copper, and we group these determinations in proportion to the quantity of copper, we shall have:

	Gain in		
Copper.	Pots — Theory.	Coins — Theory.	Coins — Pots.
0 C	— 0·075 ± 0·079	+ 0·545 ± 0·109	+ 0·620 ± 0·094
2 C	+ 0·050 ± 0·073	+ 0·805 ± 0·108	+ 0·755 ± 0·091
4 C	+ 0·335 ± 0·065	+ 0·775 ± 0·107	+ 0·440 ± 0·088
6 C	+ 0·805 ± 0·071	+ 1·180 ± 0·090	+ 0·375 ± 0·065
8 C	+ 0·635 ± 0·078	+ 1·360 ± 0·116	+ 0·725 ± 0·092

It is evident that the refining of the Pots from the Theory is nearly proportional to C, and that the refining of the Coins above the Pots or the ingots is approximately constant, though irregular, as indeed might have been anticipated.

If now we assume $a + mx$ to be the refinage in melting, when m is the coefficient of C above, and y to be the refinage in passing from the Ingots to Coin; we shall have

5 values of $a + mx$ of nearly equal weight

5 —— y of sufficiently equal weight

and 5 values of $a + mx + y$, which being the sums of the others we may neglect.

From these equations we get the following values:

$$a = -0·085 \pm 0·088$$
$$x = +0·109 \pm 0·018$$
$$y = +0·583 \pm 0·051$$

The large probable error of a compared with its value renders it very doubtful if there is any real change in scissel melting. What there is seems to be towards *loss of fineness* and it is quite certain that silver evaporates; for, in the Regenerators and flues of the Gas Furnaces (now disused) the soot was found to contain silver.

The other quantities are clearly marked, and the small probable error of x shows that the hypothesis that free copper only burns is probably true. Had a been assumed $= 0$, the value of x would have been 0 095.

The value of x shows that sufficient copper burns away to raise the fineness by 0·109 millièmes for each 100 tolahs of free copper and this quantity should be added as extra alloy: and the value of y shows that, during the processes of converting ingots into coin, sufficient alloy is removed to make the coins 0·583 of a millième finer on the average than the ingots from which they are made.

Thus in order to have accurate Rupees it would seem necessary that the Calculated or Theoretical fineness of the pots should be

$$916{\cdot}667 + 0{\cdot}085 - 0{\cdot}583 - 0{\cdot}109\ C$$
$$\text{or } 916{\cdot}169 - 0{\cdot}109\ C.$$

Now if S be the amount of pure silver in a mass and W be its weight, the fineness $f = \frac{S}{W}$ and $dW = -\frac{W}{f}\,df$.

If in this equation we put $W = 12{,}500$, $f = 0{\cdot}916667$ and $df = 0{\cdot}000109\ C$, we shall have d W or the additional alloy $= 1{\cdot}48$ C.

Practically then to get Rupees of standard fineness we should alligate to 916·169 and then add $1\frac{1}{2}$ per cent. of the free copper.

For smaller coins the increase of fineness will be greater and the alligation will be lower.

When the alloy in the silver is at all volatile or very oxidable the above rule would not serve of course. So far as possible it is sought to guard against this by melting all low-touch or suspicious silver before receipt and heating it strongly; or even, in some cases, partially refining it.

The probable error of the fineness of the pots for any one day is deduced from 10 reports of as many pots assumed to be alike. Its mean value is 0·0276 of a millième. Hence the probable error of the report of a pot is 0·087* of a millième. As each report is the mean of two single assays, the probable error of a single assay will be 0·123 millièmes.

Again, the probable error of coins used above is derived from 20 single assays of coins; its mean is 0·0806 millièmes, thus the probable error of a single coin assay on the mean of all will be 0·360 millièmes. This probable error is the probable error of a single assay combined with the probable error of a single coin as compared with the mass from which it is taken. The former has been found 0·123 millièmes, hence the latter will be 0·139 millièmes.

Again, it is customary here to check the single assays of coins daily by a double assay of the melted mass resulting from 20 coins spoilt in the stamping presses. The probable error of each such report is combined of the probable error of the mean of 20 coins together with that of a double

* I have assumed that 0·1 of a millième is a sufficient approximation in valuing the Theoretical fineness.

assay, or is 0·116 millième. The usual daily check is one such report from a melting and 10 from single assays of coins, and, as the probable errors of these values are 0·116 and 0·114 respectively, it is evident that they are practically of equal weight: when so taken the probable error of the mean fineness of a day's work will be 0·081 millième.

In receiving Bullion about seven separately assayed parcels make a lac (1,00,000) of Rupees in value. The probable error of an assay report has above been found to be 0·087 millième and that of a lac (in value) of Bullion 3·29 Rupees from assay only. The probable error of a lac of coinage is 8·1 Rupees from its assay, which shows that even for this small daily outturn, the valuation is not sufficiently good; and the uncertainty increases in proportion to the outturn, while that of the intake does not increase so fast.

With 1 lac of outturn the probable error is	2·47	that of equal receipt			
2	"	"	3·50	"	"
3	"	"	4·27	"	"
4	"	"	4·95	"	"

In order that the assay valuations of receipt and outturn should be similar, the coinage should be only 63,600 Rupees daily.

If these checks stood alone, it would be impossible for a Mint Master to feel any confidence in his work. And an assay establishment sufficiently large to value a heavy coinage thoroughly, and to make the necessary assays of single coins would be very expensive. The assays of pots are a very valuable test in a large coinage, especially when, as here, they are made nearly uniform in composition and thus check each other. In practice a coin beyond the legal remedy of two millièmes in fineness is almost unknown, but the law is now probably as exacting as it is possible to make it.

I am very greatly indebted to Mr. Edis, who was acting as Assay Master of this Mint, for the attention and skill he gave to these assays, which were more in number than the amount of work ordinarily would have called for. The accuracy of his work is proved by the small probable errors.

To obtain these data was the primary object of my experiments: incidentally, however, the weighments which are made in passing the metal from hand to hand furnish some interesting information as to the general working of the Mint which I purpose here to place on record.

The unit of weighment is a tolah (the weight of a standard rupee) of 180 grains, which is here decimally divided: 8 tolahs are equivalent to 3 ounces Troy; the English Pound contains 38·88889 and the kilogram 85·73526 tolahs. And hence—

1,00,000 Rupees should weigh 1,00,000 tolahs.

" 37,500 ounces Troy.

" 2,571·4296 Pounds = 1·14796 Tons.

" 1,166·3811 kilograms.

The Melter receives his silver in bars and lumps, and also as scissel and rejected blanks and coins. The portions for each pot and its proportion of copper are separately delivered. His results are—

1*st.*—Ingots which can be weighed as soon as cleaned.

2*nd.*—Chippings from the bars and spillage which require to be cleaned before weighment: usually next morning.

3*rd.*—Ends of ingots and pieces cut off before delivery to the laminator as not being fit for straps.

4*th.*—He has drosses and sweep which contain more or less silver and of which the value cannot be known till later.

The following table shows the results obtained in this department from these experiments, as to which it must be noted, that while the metal is accurately weighed to the Melter, the future weighments are less accurate until it takes the form of coin, for it would be impossible to give the same time and care to weighments which are mere checks that are necessarily given to the more important ones; or to use balances for them as delicate.

Melting No.	Weight given to Melter.	Outturn.			Approximate Loss.
		Good Ingots.	Heads and Pieces.	Particles.	
	Tolahs.	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*
89	119,447·0	118,908·8	0	461·2	77·0
92	125,148·0	124,573·6	0	505·4	69·0
93	125,121·0	124,667·8	0	357·5	95·7
94	125,076·0	124,557·8	0	426·8	91·4
95	125,090·0	124,642·6	4·0	388·0	55·4
96	125,133·0	124,676·8	0	387·4	68·8
97	124,023·3	123,114·8	103·0	754·5	51·0
98	124,530·0	123,496·4	531·0	442·4	60·2
114	125,434·0	124,691·2	280·0	366·2	96·6
115	125,973·0	125,480·4	0	423·9	68·7
Sums.	1,244,975·3	1,238,810·2	918·0	4513·3	733·8
Percentage.		99·50480	0·07374	0·36252	0·05894

Hence it will be seen that about $4\frac{1}{4}$ per cent. alone of the weight is unaccounted for at once, and that, after the particles are all recovered, the amount left in the drosses is about 6 parts in 10,000, and this includes the alloy burnt away. At the rate of $1\frac{1}{2}$ per cent. on the free copper, the loss on that metal would have been 607·2 tolahs, leaving only 126·6 tolahs or 0·010169 per cent. of the value as a real loss, but what is shown above fairly represents the experience of some years as regards the net loss of weight by burning.

When passed by the test of assay, the ingots go to the Laminating Department, and from this time no trustworthy valuation can be made till the coin is ready for issue. In all the succeeding processes metal is lost by abrasion and by alloy being burnt in the annealing processes and removed in the pickling necessary to clean the surface of the silver for stamping. On the other hand, oil and grease from the machinery adhere to the surfaces and (till the blanks are cleaned) a small portion of oxide adheres and thus the weight is increased.

It will be seen from the following table that the Laminators cut off and reject about 2 per cent. of the metal received, and that, very little weight being apparently lost, the outturn of good blanks is nearly 60 per cent. of the weight of ingots. Good blanks here of course meaning those which are perfect in form and ready to be tested as to their sufficiency in weight. When the whole sweeps have been refined and the silver in them recovered, there is ordinarily a gain in the Laminating Department from the causes I have spoken of. It appears that in a mean of several years the result of crediting the recoveries of sweep &c., has been a small gain in weight in these Departments, amounting to 0·00003 of the amount. It is here that the effect of bad silver is mainly felt: when silver which is derived from ornaments, and a few other sources, is used without being well refined, the floors of the laminating rooms are covered with spangles, causing of course a heavy loss, and the edges of the straps are ragged, so that the outturn of blanks is much less than the normal amount, while the weight of scissel is sensibly increased.

Melting No.	Weight of Ingots.	Laminating.			Fine Rolling.		Cutting out Blanks.			
		Good straps.	Ends and pieces.	Loss.	Good straps.	Loss.	Good Blanks.	Bad blanks and pieces.	Scissel.	Loss.
	Tolahs.	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*	*Tolahs.*
89	118,908·8	116,565·0	2,328·3	15·5	116,558·1	6·9	69,699·4	418·2	46,445·7	— 5·2
92	124,573·6	122,337·5	2,222·5	13·6	122,333·8	3·7	73,944·0	310·3	48,071·5	+ 8·0
93	124,667·8	122,707·1	1,962·8	— 2·1	122,704·6	2·5	74,186·2	265·6	48,240·8	+ 12·0
94	124,557·8	122,320·0	2,222·2	15·6	122,316·2	3·8	73,956·7	207·7	48,156·3	— 4·5
95	124,642·6	122,386·3	2,241·1	15·2	122,385·2	1·1	73,946·4	228·9	48,202·1	+ 7·8
96	124,676.8	122,368·9	2,293·4	14·5	122,363·3	5·6	74,110·1	226·5	48,025·4	+ 1·3
97	123,114.8	120,952·8	2,151·6	10·4	120,950·7	2·1	73,381·0	314·5	47,267·5	— 12·3
98	123,496·4	121,114·2	2,356·4	25·8	121,113·9	0·3	72,747·4	254·5	48,105·9	+ 6·1
114	124,691·2	122,230·3	2,448·1	12·8	122,226·1	4·2	73,075·5	535·1	48,618·8	— 3·3
115	125,480·4	123,011·4	2,450·2	18·8	123,009·1	2·3	73,631·5	356·1	49.029·6	— 8·1
	1,238,810·2	1,215,993·5	22,676·6	140·1	1,215,961·0	32·5	732,678·2	3117·4	480,163·6	+ 1·8
Percentage of Ingots,		98·15818	1·83051	·01131	98·15556	0·00262	59·14370	0·25164	38·76007	0·00014
Percentage of Receipts,					99·99732	0·00267	60·25507	0·25638	39·48841	0·00014

The blanks when cut out pass to an officer whom we call the Adjuster whose duties are very important. After being slightly cleaned the blanks are individually weighed in Automatic Machines, the light blanks are returned to the melting pot, while those that are too heavy have their weight reduced. This used to be done by hand, but we have recently made a machine which deals satisfactorily with about 1500 blanks an hour. As the farther processes of coining reduce the weight of the blanks, an allowance has to be made here for this reduction, and it is part of the adjuster's duty not only to keep his machines in order and see that each blank is within the remedy allowed, but further to check the weights of the bags (each containing 2000 blanks) and see that each bag is within the much narrower limit laid down for his guidance, and that finally even then they are not all on one side so that the error would accumulate.

Melting No.	Tale of Blanks.				Delivery to Milling Dept.	
	Received.	Heavy.	Medium.	Light.	Tale.	Weight.
89	69,662	2,965	63,933	2,764	66,000	66,035·9
92	73,890	2,617	68,928	2,345	70,000	70,042·5
93	74,124	3,086	68,790	2,248	70,000	70,045·0
94	73,906	2,416	69,283	2,207	70,000	70,044·0
95	73,896	2,009	69,959	1,928	70,000	70,044·6
96	74,056	1,420	71,277	1,359	72,000	72,045·4
97	73,300	3,143	67,971	2,186	70,000	70,044·1
98	72,684	2,744	68,232	1,708	70,000	70,044·1
114	73,024	3,028	67,783	2,213	70,000	70,045·5
115	73,582	1,430	70,847	1,305	70,000	70,045·5
Sums.	732,124	24,858	687,003	20,263	698,000	698,436·6
Percentage.		3·39533	93·83697	2·76770		

The proportion of light and heavy blanks beyond remedy is about what has now for many months been usual: the Tale of Blanks sent on is smaller in proportion, and I have not thought the percentage worth giving. Of course it includes heavy blanks reduced, but only whole bags are sent on, and thus not only has the percentage sent on been smaller but it is more regular than usual: I believe too that the weight is more regular.

The experiments were not sufficiently extensive to show the working of the machine for reducing blanks, but the following data will show this and give a comparison with the old method of filing by hand.

In December 1878,	283,639·9	Tolahs of blanks were reduced
by machine to	282,366·5	
Silver removed	1,273·4	

The recovery was 1243·4 Tolahs of particles worth 1173·61 Rs., showing a loss of 2·356 per cent. in weight of particles
and 7·836 „ „ in value of the silver

In December 1877, 233,349·8 tolahs of blanks were reduced
by filing to 232,049·4

Silver removed 1,300·4

The recovery was 1223·7 tolahs of particles worth 1129·28 Rs.,
showing a loss of 5·898 per cent. in weight of particles
and 13·236 „ „ in value of silver.

The accuracy with which a certain amount can be removed per bag has been increased and the cost greatly decreased, for one boy can attend on two machines reducing, if needed, 21,000 blanks a day, whereas this used to require ten men, and as so many were not always available, work often fell into arrears.

I have now to trace the blanks through their last stages till they become rupees.

The adjuster passes on the blanks to what is here called the Milling Department, but in the Royal Mint the work is called Marking. In this process, a few blanks are spoiled when the setting of the machines is defective. The final annealing and pickling come next, and the rupees lastly issue from the Stamping Press, only requiring examination before final issue.

I have not thought it worth while to give here the separate results in the rooms devoted to these purposes severally. Defects in the Milling Department and those in the annealing sometimes pass till they are found out in the presses or in the final scrutiny.

	Blanks from Adjuster.		Rupees fit for issue.		
	Tale.	Weight.	Tale.	Weight at rate of receipt.	Weight after coinage.
		Tolahs.		Tolahs.	Tolahs.
89	66,000	66,035·9	64,832		64,834·0
92	70,000	70,042·5	67,940		67,943·9
93	70,000	70,045·0	68,956		68,961·9
94	70,000	70,044·0	69,005		69,007·8
95	70,000	70,044·6	67,910		67,911·6
96	72,000	72,045·4	70,459		70,458·6
97	70,000	70,044·1	67,738		67,735·8
98	70,000	70,044·1	68,507		68,506·6
114	70,000	70,045·5	68,058		68,057·4
115	70,000	70,045·5	68,407		68,411·6
Sums.	698,000	698,436·6	681,812	682,223·4	681,829·2
Percentage of blanks.			97·68080	Loss of weight in work.	394·2

We have already seen that 59·1437 per cent. of the weight of ingots is converted into blanks. These were in tale 732,124, of which 687,003 were good and 24,858 heavy but capable of being reduced, or in all 711,861 capable of being coined, and we now find that of those sent on from the Adjusting Room 97·68080 per cent. become good Rupees. If then, all had been sent on we might have expected 695,351 good coins whose standard weight would be 56·131 per cent. of that of the ingots.

Further, we find that 681,812 blanks as they leave the adjuster lose in after processes 394·2 tolahs, or 70,956 grains, in weight. Thus the average loss on each is 0·10407* grains, and each blank leaving the adjuster should on an average weigh 180·10407 grains, and each bag of 2000 blanks 2001·156 tolahs.

The general procedure of Minting has been unchanged for very many years, but, as the effects of the coining processes must vary with details of manipulation impossible to define exactly, I some time ago recognized that it was necessary to modify both the amount of additional alloy and the excess weight of the blank over the coin, and resolved to investigate the matter.

I now offer these results to a wider circle than they were originally meant for, because I think that many will be interested in knowing the care that is taken to keep the coinage of India to its standard value. I hope too that it may lead to the publication and circulation of similar results from other Mints and thus to advance in Minting.

* This amount, like the y of the fineness (see note p. 60), varies with manipulation and the quantities are dependent on each other.

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Part II.—PHYSICAL SCIENCE.

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VII.—*Note on the old Burmese route over Patkai viâ Nongyang (viewed as the most feasible and direct route, from India to China).*—*By* S. E. Peal, Esq.

(Received 12th March; read 2nd April.)

(With Plates IV, V, VI, and VII).

Perhaps in no other part of the world can be found a parallel to the small and peculiar region immediately East of Assam, and that separates India from China.

On each side of it we see a large Empire, numbering its people by hundreds of millions, densely located, and who have been for many centuries conspicuous for their industry and intelligence, and with records extending far into the past.

Yet across this interval of some 200 miles only, we find little or no intercourse or trade.

Undoubtedly towards the North and North-East, the difficulties of finding an outlet at any reasonable elevation are demonstrated. In most cases the routes must cross at least 10,000 feet or more, besides being proverbially difficult.

Assam has never to our knowledge been entered by any large force from the North East, or due East, and the only invasions, (excepting those up the valley from the west) have been over Patkai, by the Ahoms and Burmese.

The discovery of a good trade route between India and China, has long exercised many minds. Routes *viâ* lower and upper Burma, to Yunan, have been of late years advocated and partially tried, but all present a consistent feature in the extreme difficulty of the country beyond a certain point.

The experience of the Grosvenor Mission clearly confirms this, and indirectly points to the necessity of crossing the intervening valleys higher up—(the country between Momein and Yunan being reported extremely difficult).

Keeping these facts in view, a few remarks regarding the old route out of Eastern Assam, *viâ* Patkai, and the possibility of a good trade route with western China, *viâ* the Sittang country to the Yang-tse-kiang, may be of some interest.

Some years ago attention was directed to this route and endeavours made to induce Government to explore it.

In 1868 Mr. F. A. Goodenough of the Calcutta Chamber of Commerce submitted a report to Government for co-operation in the matter, urging that the time had come when such an expedition was advisable and likely to be a success. The local authorities, however, viewed the proposition with such marked coldness, that no action was taken in the matter.

In 1868 Mr. H. L. Jenkins crossed the Patkai near the head waters of the Namrúp river, discovering the Nongyang lake on the other side, but he was unable to proceed further that year.*

In 1869 he again started in company with Mr. A. J. Peal, and followed the track of the previous year, and passing the Nongyang lake, found no serious obstacles until they reached the first Singphú villages at Númyúng in the Húkong valley,† where advance was prohibited by the chiefs.

After fruitless attempts to overcome their opposition, the party was compelled to return to Assam, selecting the route by which Dr. Griffiths passed from Assam to Burma in 1837, and which is more to the west.

By the route in, the line generally was both more circuitous and difficult.

Remarking on the latter Mr. Jenkins says, "It is much to be "regretted that Griffiths chanced to take this route, for it is doubtless "owing to his description, that a general impression has arisen that the "Patkai range is a formidable barrier erected by nature to prevent com- "munication between India and the countries lying to the East."

Having been more carefully and recently described than the others,

* See Proceedings A. S. B. 1869, page 67.

† See Proceedings A. S. B. July 1870, page 230 *et seq.*

" Griffith's route" has come to be taken as a type of the difficulties on this question, and has undoubtedly led many into error.

Tracing the subject back, we find that in 1816 some 6,000 Burmese troops and 8,000 auxiliaries crossed Patkai into Assam, at the invitation of the Raja (Chandrakant).

Soon after, it is said, 30,000 followed under Keo Minghi, who returned to Ava in 1818, leaving about 2,000 men behind him in Assam.

About 1821 Maha Thilawa, the Burmese general in Assam, was involved in disputes with us, and in 1822 Menghi Maha Bandula led 18,000 men over Patkai and made Assam virtually a Burmese province.

In 1824, war was declared by us, and the question of routes into Burma was eagerly discussed. Four were declared practicable, two by sea, and two by land, *i. e.*,

Land route,	Calcutta	to Ava	viâ Assam,	1,433 miles and	170 days.
„	„	„	Manipur,	1,052 „ „	107 „
Sea route,	„	„	*viâ* Aracan,	835 „ „	39 „
„	„	„	Rangún,	1,446 „ „	82 „

Of the land routes, it was settled that the line *viâ* Assam, and over Patkai was by far the best, but that *viâ* Rangún offering better transport for stores was ultimately adopted.

In 1828, Lieut. Burnett reported on the route by which the Burmese had entered Assam, and it was no doubt on this that Pemberton relied in his " Report on the N. E. frontier" in 1835.

" The passage of the Patkai," he remarks, " is represented as easy " when compared to the seven or eight equally lofty ranges that must be " crossed between Cachar and the Munipuri valley."

On all occasions Pemberton wrote in high terms of this pass, and, after his surveys on the Munipuri side, we may consider him one of the best authorities on the matter.

Sir Ashley Eden has truly said that no man before, or since, has ever had such opportunities of collecting reliable information on the subject, and very few would, or could, make such good use of them.

It was in 1837 that Dr. Griffiths, who was one of the Tea Commissioners, crossed from Assam to Ava. Yet though he started from Bisa, and passed Mainkwan, his route over that portion nowhere coincided with Pemberton's account of the old Burmese one.

After leaving Bisa, in Assam, he took a considerable detour to the west, the reason for which is not I think to be found in his journal, but is attributable to the fact that along the old route villages were maintained, so that not only was the route itself always kept more open and in repair, but provisions obtainable all along.

Whether these villages were kept there by the authorities or remained there of their own choice, and benefitted by the line of trade we cannot now say, but soon after the close of the Burmese war, they migrated westwards; possibly the state of frontier anarchy that followed left them too often at the mercy of necessitous soldiery, to avoid whom they retreated to the higher ranges.

On Griffiths' arrival, therefore, at Bisa, instead of pursuing the old route up the Namrúp river, towards the Loglai basin, we find he made a sudden turn westward and passed through the "Morang Nága" country, crossing Patkai near Yugli at 5,000 feet elevation, and subsequent ranges at 3,500 and again 5,100 feet, Nongyang lake being left fully 20 to 25 miles to the east.

The old route, in fact, at that time had been abandoned—neither food nor transport could be got there—and he was compelled to go where these were obtainable; the old path also by that time would have been covered by jungle and more or less impracticable.

Properly speaking the name Patkai applies only to the highest ridges wherever they occur; in few places are they continuous for any distance; the water parting is often cut up into distinct groups of hills with many low places intervening, more especially towards the eastwards, where from the Nongyang lake, they sink lower and lower, to where Singphus assert they have crossed nearly on the level after Rhinoceros.

It is in this neighbourhood that Mr. Jenkins and others consider it extremely likely that passes may be found at even less than 2,000 feet elevation, and it is evidently near here that the old route lay. The basins of the Namrúp on the north and Loglai on the south, so closely approach each other from opposite sides, as to leave but *one march* between them from water to water.

These two drainage basins, shewing as they do the lowest levels on each side to be in such close proximity, and where the soft strata is most rapidly denuded, naturally indicate the lowest part of the range.

Pemberton describes the old route as follows:

"Bisa, which is the principal village and residence of the head of the "Singphu tribe of that name, stands about 10 miles from the gorge of the "defile through which the pass leads, and the first stage is to the Namrúp "Nulla, on the banks of which good camping ground is found 16 miles "from Bisa.

"Between the 1st and 2nd stages two hills are crossed, the Tontúk "and the Nunnun, neither of which present any difficulties that might not "be easily overcome. The Namrúp flows between these hills, and the "Nunnun* falls into it a short distance from the second encampment;

* Namphúk.

" there is but little jungle in the vicinity of the camping ground, which " has space for a tolerably large body of troops.

" The distance of this stage is 12 miles.

" The third stage, which extends from the Nunnun to the Kasi Nulla, " flowing at the northern foot of the Patkai hill, is about 7 miles.

" After leaving the Nunnun and crossing a low hill, the Namrúp is " again reached and its bed travelled over for 5 miles.

" This portion of the route is the worst, as the bed of the nulla is " filled with large stones and rocks over which the traveller finds it diffi- " cult to make his way, but the Burmese appear to have avoided it " by cutting paths through the forest above.

" From the Kasi Nulla to the summit of the Patkai central ridge, the " distance is about 4 miles, and the ascent is said to be very precipitous, " but it is quite evident from the description given, and the manner in " which the Burmese travelled that there are no serious obstacles which " the judicious employment of a few pioneers would not readily overcome. " From the Kasi Nulla at the northern foot of the Patkai hill across to " the Loglai the first nulla met with on its southern declivity is one long " march, and there is said to be a very inadequate supply of water between " these two streams.

" From the Loglai to old Bisagaun, the original site of the Singphu " tribe, not far from the gorge of the pass on the southern or Burmese " side, there are six marches none of which are either very long or diffi- " cult."

In the above quotation from Pemberton it is noteworthy that the first two, if not three, marches coincide with the route taken by Mr. Jenkins *viâ* the Nongyang lake in 1869.

Both follow the Namrúp for some distance and then leave it where the river makes a long detour to the east, and near to the village of Namphúk, and thence crossing some low hills, descend again to the river, thus cutting off a large bend.

After this, even, it is evident that the routes coincide, and where they diverged it is not now easy to find.

It is extremely probable that the old Burmese route that Pemberton describes, lay a little to the east, for though Mr. Jenkins states they could have crossed the ridge some 500 or 600 feet lower, by keeping more *west*, yet the ranges to the eastwards are generally *still* lower.

From the foregoing it is obvious that the old route held longer to the basin of the Namrúp, and debouched on the Loglai higher up, thus escaping Digum Búm ; the two routes, however, are near each other, and fairly direct, which Griffiths' was not, but it is only by a careful study of the locality

that the best site could be found, all is now forest, and the route line will have to be re-discovered; there can however be little doubt that it crossed Patkai close to this point, and probably at less than 2,500 feet above the sea level, and say 2,000 feet on the spot.

The approaches to Patkai at the part indicated, present no insuperable difficulties on either side; undoubtedly a strip of hilly country extends for some distance north and south, parallel to the main range or ranges, but the country on the northern flank consists of tolerably low hills and rolling land, and on the other side, it seems to be repeated between Digumpáni and the Turong.

The paths on that side, in fact, are now confined mainly to stream-beds between which they cross low spurs; the latter is characteristic of the route between Loglai and Namyung, where it goes by the Kaisu, Namlip, Yúngsúm, and Yungmoi, to the village of Númyúng in the Húkong, or Dinoi, valley.

It is unfortunate that ever since our taking possession of Assam most works that allude to routes between India and China, treat the passage of these ranges as an almost insuperable obstacle.

Excepting by Pemberton, and latterly Mr. H. L. Jenkins, it is generally looked on as a subject hardly worth discussion, or investigation.

It is taken for granted that there is no good, or even fair, route from Assam *viâ* Húkong to the Shán States, and that the Patkai is simply an impassable barrier, whereas the truth is that the more the matter is investigated the more likely it appears that this old route will turn out to be not only the best, but perhaps the *only* available trade-route out of upper Assam, by which we can get anywhere *East*.

From the summit of Patkai, near where the old route crossed, the view south-west is across a rather large triangular valley having a sheet of water in it called "Nongyang" several miles long, and a wooded island towards the eastern extremity. The "Nongyang River" falls in from the west after a course of 12 or 14 miles, mainly between two high and continuous ridges, each called Patkai, that were crossed by Drs. Griffiths and Bayfield, and which river has generally been considered the boundary between Assam and Burma at this part. After passing through the lake the river flows out east into the Loglai, or Laklai, going south and east to the Turong.

On the south, Digam Búm rises very conspicuously beyond the Nongyangpáni; it is probably not less than 3,000 to 4,000 feet high, the surrounding hills north and south being 2,000 to 3,000, with water-courses and passes at perhaps 1,000 feet above the sea level.

Beyond Digam Búm lie the first Singphú villages in the Húkong

valley, the nearest being Númyúng, situated on a river of the same name that rises far to the west, south of Patkai and nearly opposite the Tirap valley (of the northern slope).

The name of this river has been so variously rendered as to make its recognition at times difficult; we find it as the Ramyoom, Kamyoom, Kammiroan, Nam-ma-ron, and Námyúng, the latter no doubt most correct. After passing the village it flows S. E. and falls into the Túrong. From Namyung there is constant intercourse with the south, west, and east, over an undulating but not difficult country. Traders generally pass it *en route* for Assam.

It is extremely significant that the name "Patkai" (which is an abbreviation of Pat kai seng kan*) originated on the pass at the part above indicated, in consequence of an oath there ratified between the Ahom Raja "Chudangpha"† on the north side, with Súrúnphai, the Nora Raja of the south side, whereby each bound themselves to respect the Nongyang-páni as the boundary, and that between them, ere separating, they erected two sculptured monuments, as memorials of the treaty on each bank of the river.

Previous to this period the range there was called "Doikaurang" Doi = Mountain, Kau = 9, and rang = united, namely the place of "nine united hills," or where nine ranges converge, which latter singularly confirms all we know of the place already.

At the site in question, but one range is crossed from water to water, whereas to the west, at least 8 or 9 conspicuous ridges must be crossed ere the plains are reached beyond.

The name "Doikaurang" was bestowed by the first Ahom Raja "Chukhapha," when passing from Nora, or Pong, to take Assam in 1228 A. D.

It seems clearly demonstrated by this time, that there are no trade routes to be expected *viâ* the "Brahmakund," the "Daphapáni," or "No Dehing" valleys, and nothing intermediate is possible.

The sufferings of Lieut. Wilcox and his party in 1827-8 during his attempts to penetrate eastwards are sufficient to deter any re-surveys of those routes for such a purpose.

The Mishmi hills to the north again, or the Abor country, are equally uninviting, nor are lines of traffic more likely through the Daphla hills, except by cattle, and over passes that on the north, as on the east, are not less than 10,000 feet, if as low.

* Pat = cut, Kai = fowls, Seng = oath, Kan = taken.

† Chudangpha's ambassador was the Bor Gohain Tiatanbing, and that of the Nora Raja, Tasinpou, date 1399-40 A. D.

To the south-east, even if a little too far south, must we turn, if anything approaching a trade route out of Assam is to be found, and at or near the old Burmese route, we at once get one that is remarkably easy and that with comparatively little outlay would be suitable for wheel traffic.

The station of Gauháti on the Brahmaputra, is now connected by a fine carriage road to the Shillong plateau, which rises to between 5,000 and 6,000 feet, the last 3,000 feet of which is in a distance of only 12 miles.

The difficulties of crossing Patkai are, at least, *less than half* of those met with on such a road, and that we can easily overcome them we have demonstrated.

Having glanced at the position of the route *viâ* Nongyang, it may be well to indicate those of several others, leading from upper Assam into before noted, the valley of Hukong.

There is a route through the Nága hills west of the Tirap river, and east of the Disang, that enters at the Namsang Nadi, a tributary of the Dihing, and not far south of Jaipur. This line after traversing the bed of the Namsang for some distance crosses the Patkai by the Takum pass, (say 5,000 feet) and thence follows the Namyung till it joins Griffiths' route (the latter is often called the Tirap route).

A second entrance to this same Takum route is from Borhát on the Disang river ; the water-shed about here, though, rises to 6,000 and 7,000 feet and is a more continuous ridge.

The late Colonel Hannay advocated a line viâ Bhitor Namsang on the Tankak river in the Sibságar district, passing through the Nága villages of Sangloi, Sangsa, Sangba, Langia (or Longra), Horu Khet, and Chotagaon to Singolani, the latter situated on the Dinoi some 45 miles north and 30 west of Munghhong, and near the western extremity of the valley of Hukong. This line presents no very serious obstacles and is much used.

Another route has been proposed entering the Dhansiri valley, passing Samaguting, and thence *viâ* Phre re ma, Gopsi ma, Dibu ma, Teseshu ma, Tajoga ma, Kaza ma, Jessa ma, Kochapa ma, and lastly Teuchu ma on the Dinoi.

This, however, is over a long line of hilly country and ends far to the west in the valley of Hukong, and from whence any road east must cross the whole line of northern drainage, whereas the endeavour should be to keep in the *level plains of Assam* as long as possible, having in view the facilities on the southern side, and also to penetrate the mountain barrier where not only lowest but narrowest.

Once the plains of Hukong are reached, say near Numphin or old Bisa,

on the Turong, the line would keep north of the Dinoi River, crossing a country covered by open undulating grass plains, whence *viâ* the low Kako hills it could join the trade route to Múngla east of the Irawadi.

The Shuemai, or Phungmai Kha, on which this town is situated, is generally believed now to be the main stream of the Irawadi and flows from the N. E. through a large plain or valley called the Sittang country. There can be little doubt but that Dr. J. Anderson* is correct in supposing that this river has its rise in Eastern Tibet.

It is hardly necessary to remark that a route over Patkai to Upper Burma *alone*, is not pressingly required; what is really in demand (and will continue in demand until solved) is a good route joining India with China.

The advocates of a route to Western China may be divided into three parties: 1st, those who would start eastwards almost at once from near Rangun, and may be called the "Marine" party: 2nd, The far more legitimate one that advocates a line through Burma to the upper provinces, ere starting east, so as to gain not only the China trade but benefit Burma itself by a good line of internal communication; these would be the "Burmese" party: 3rdly, There is a large party both in India and England, if not also in China, who are in favour of a more direct line between India and China if it were possible, even if it had to pass viâ the Hukong valley, and across the northern extremity of Upper Burma, towards Talifu and the Yang-tse-kiang.

These three parties are, so far, distinct, if not actually in opposition to one another, but the question is becoming gradually much simplified. The Marine (or Manchester party) now that India can, and will, beat Manchester in the cotton trade, is certain to die a natural death; a trade route with China *viâ* the *mouth* of the Irawadi is not in demand, so that only the Burmese and Indo-Chinese parties remain. These should really not be found in opposition at all, if the Patkai route is possible; on the contrary, their interests are almost identical; a junction on the upper Irawadi would benefit both.

To imagine that the trade to England from western China, would go by the valley of Assam, while the Irawadi was open, would be absurd. It would be equally so to expect the Indian trade to go *viâ* the Irawadi; each would take what legitimately belonged to it; indeed, without combination between these two parties it does not seem likely that a route to Western China will ever be possible. There is actually no reasonable ground why either should oppose that combination, while there is everything to gain by union.

The immediate future of Burma it is not difficult to forecast, and with

* Journ. Royal Geog. Soc. Vol XL, 1870, p. 286.

such an object in view, as a route joining the two largest empires of the East, it behoves us to look ahead.

The difficulties in connexion with a good trade route from India to China *viâ* Patkai and upper Burma are not *physical ones*, as has hitherto been supposed; the only real obstacles are political ones, which would vanish, the moment Chinese and Burmese jealousy was overcome.

The obstacles to trade, in fact, are all confined to one tribe or race, the Singphús or Kakhyens, who inhabit the hills between Assam, Burma, and China, and by a state of tolerated anarchy, effectually prevent peaceful intercourse.

Until some central authority is recognized, and joint action taken, it is not easy to make head against these turbulent clans; an alliance for their suppression, would at once solve the Indo-Chinese route question, viâ Assam.*

Appendix.

The following few extracts from the diary of Mr. A. J. Peal serve to corroborate the remarks made by Pemberton before quoted, as to the line of route.

"December 6th, 1869. We had great difficulty to get the men to start, and were not off till noon, crossing soon after a couple of low hills, due south of the village (of Namphúk), we struck the Namrúp again and eventually camped 3 or 4 miles up its bed.

"7th. Continued up the bed of Namrúp, and subsequently the Nambong, camping at mouth of the Nanki.

"8th. Marched up the bed of the Nanki after boiling water at $211\frac{1}{2}°$ thermometer at 56°, and commenced the ascent of "Patkai" at 11·30 A. M. reaching the summit at 2 P. M., after a hard climb. Boiled water on the top at a temperature of 208°, thermometer 66°. We camped at the first water on the southern slope at about 400 feet down, and had a fine view of the Nongyang lake and also the Brahmaputra.

"9th. We boiled water ere starting at $208\frac{1}{2}°$, thermometer at 55°, descended pretty easily and rested at the ford of the Nongyang river at 11 o'clock, route E. S. E. Subsequently crossed a spur of Digam Búm nearly as high as Patkai, camping at a small stream half way down the other side, course S. E. and tortuous, say 14 miles.

"10th. Started about 9 A. M. and by 10·30 reached the Digampáni, crossing and re-crossing several times, and after ascending a low ridge came suddenly on the Loglai (or Loklae Kha) of which we had a fine view.

* The greater portion of this note was written in 1872.

The bed some 80 or 100 feet below was say 100 yards wide, composed mainly of slaty rock, and with long rapids.

"11th. Marched down the bed of the Loglai, which being composed of boulders was very fatiguing, we passed some fine rapids, and camped at the mouth of the "Kaisu," having only done about 8 miles. We found no dew south of Patkai at night.

"12th. We ascended the bed of the Kaisu and crossing "Kasukú," (or hill) struck the Namlip, after going down which for some 6 miles, camped at the mouth of the Yungsum, a small stream.

"13th. From the Yungsum we crossed a low ridge to the Yungmoi and followed it out to the Namyung river, which we reached at 4 P. M., finding it about 80 yards wide and flowing over shingle. Men at once started on to the Númyúng village for food. J. brought back rice, fish, &c.

"14th. Reached Númyúng village in half an hour after breakfast, finding a nice open place and rice lands, and were very hospitably received."

The party were here met by messengers from the chief of the Dinoi villages prohibiting an advance. While waiting result of a friendly message in return, many traders passed, with daus, amber, &c., for Assam; others again came in from Assam, and from the Nága hills west; a great deal of information was gained from five men who had come from near the Irawadi, due east, they said a great many Chinese passed through their villages to and fro, trading with Hukong, so much so that both they, their wives and even children, could understand Chinese.

The extracts relating to the return journey also completely corroborate what was already known as to the difficulties of the Tírap or Griffiths' route, by which the party returned.

"26th December. Started at 10 A. M. back, after some trouble with the carriers who refused to take the loads by that route, through the Nága hills. He reached the mouth of the Chilly (Tsili) about 4 P. M. after a march of 15 miles.

"27th. This day we arrived at the first Mosang Nága villages; distance 10 or 12 miles.

"28th. Passed through several Mosang Nága villages and camped in one with 60 houses at 1,500 feet elevation.

"29th. After starting, we ascended a very high hill or range (Gedak Búm, say over 5,000 feet) and then down some 500 feet to a Nága village on a spur, surrounded by other villages not far off. They have a fine breed of cattle, and a peculiar hairy little dog like a terrier.

"30th. To-day crossed another high ridge, and camped some 300 feet

down it on the other side, at the first water, it was Patkai. Found it very hard work, as the southern faces of the ranges are either open cultivation, or deserted *jhúms,* destitute of shade, the path in many places almost perpendicular.

"31st. Again over a ridge of Patkai; water boiled at 203°, and we started down to the valley of the Namtsik, where we camped.

"January 1st, 1870. Crossed another high range, over 3,000 feet, crossed a stream, ascending again to Yugli at 3,000 feet or more, from whence we had a fine view of the Tirap valley, and Rangatu rising beyond it to over 3,500 feet, the peak about 4,500.

"2nd. We came down from Yugli to the Tirap river, rising again to 3,500 feet over Rangatu, thence along a ridge passed Rangnam, and down to the river Ti keng, thence up to Kongtam 2,000 feet and *viâ* Wado to Tirap Múk on the Dihing river."

*Elevation of some of the "Passes" north of India, Nipal and Assam, also of some in Tibet.**

	feet above the sea.
Chang chenmo, (Lon. 79°, Lat. 34° 30′)	19,000
Cho morang la, (Tibet)	18,760
Cho la, (Sikim Chumbi)	15,000
Donkia, (Sikim Tibet)	18,466
Ga la, (Nipal) „	16,700
Gua tina la, (Sikim Chumbi)	14,000
Jelep la, (Sikim Chumbi)	13,000
Kongra lama, (Sikim Tibet)	15,740
Kambala, „ „	
Khalamba la, (Tibet)	17,200
Lágúlúng lá, „	16,000
Mariamla, „	15,500
Nilam, (Nipal Tibet)	16,623
Nola, „ „	16,720
Photulá, (To Tibet)	15,080
Tiptala, (Sikim)	
Taklakhar, (Nipal Tibet)	
Taukra la, (Sikim) „	16,083
Walung chung, (East Nipal and Tibet)	10,385
Yakla, (Sikim Chumbi)	14,000
Tulalah, (Bhutan)	10,000

* These are not *selected* passes, on account of their altitudes, but are those best known at the moment of writing.

The average height is 15,458 feet.

Dr. Griffiths' route.

Extracts from Dr. Griffiths' notes regarding the route over Patkai, starting from the Dihing River.

Date.		Miles.	Direct.	Eleva-tion.	
Feby.	19th,	12	S.W.	1,029	crossed Tirap several times and along difficult places.
"	21st,	10			winding difficult path: camped on Tirap.
"	22nd,	12		1,029	route difficult.
"	23rd,	12	S.S.E.	1,413	out of Tirap, crossed high ridge 2,500 feet down to Namtsik.
"	24th,	10	S.S.E.		marched up the bed of Namtsik.
"	25th,	4	S.S.E.	3,026	ascended ridge to 3,500 feet.
March	3rd,	15	S.S.E.	5,000	started up Patkai 1,500 feet above camp, down to boundary (*i. e.* Nongyang).
"	4th,	10	E.S.E.		fatiguing march, (perhaps down Nong-yang).
"	5th,	4	E.S.E.	2,138	met Dr. Bayfield.
"	13th,	7	E.S.E.		down Nam ma roan, (*i. e.* Namyung) passed village.
"	14th,	7	E. by S.		Do. Do.
"	15th,	13	E. by S.	5,516	ascended some hours to 5,576 feet, to Natkaw and Kusi. camped at 5,516 feet elevation.
"	16th,	13	S.	3270	descended considerably, camped on Gedak bum (path over 5,000 feet).
"	17th,	10	E.S.E. E.		descended Gedak to Namtsik.
"	18th,	18	N.N.E. E.		Route circuitous, heavy jungles to Namtsik and Turong Rivers.
"	22nd	13	S.S.E.	1,340	Shelling Khat and Kulyung.
"	23rd	10	S.W.		to Lamún and Tsilone River B. Dinoi River 300 yards across.
"	24th	17		1,064	to Mainkwon.

The above has been collated, and names where wrong spelt, altered.

Pemberton's report of Route from Bisa.

Probably from Lieut. Burnett's report, March 1828.

Stages	Miles	
1st,	16	Bisa, 10 miles to the gorge and thence to Namrúp River.
2nd,	12	Namrup, over 2 hills, camped at Nunnun.
3rd,	11 ?	Nunnun, to Namrup again, and on to the Khassia, or Khasi.
4th,		Khasi to summit Patkai, 4 miles, down to Loglai.
5th to 11th		Loglai to old Bisa, 6 days.
12th to 20th		Bisa to Magaung 8 marches.

Mogong or M'gaung is the Mong maorong of the Shans, and on the Mogong river, that falls into the Irawadi.

The first eleven stages are nearly identical with Dr. Griffiths' route.

Route from Tirap to Hukong (Mainkwan) by Mr. H. L. Jenkins.

STAGES	ASSAM TO HUKONG.	and HUKONG TO BAMO.
1.	Terap muk to Kongtam.	A. Hukong to Jambu hill.
2.	Kongtam „ Youngbhi.	B. To Lebong village on the Nunkung.
3.	Yungbhi „ Yugli.	C. Down it to Namsang múk.
4.	Yugli over Patkai.	D. Do.
5.	Patkoi to Mosang Nága village.	E. Land march to Santok hill.
6.	Nága village to Johanghai.	F. To Nunhang River.
7.	Johanghai to Wada pani.	G. Down Do.
8.	Wada pani to Gedak Búm.	H. Do. to Benauko Singphu village.
9.	Gedak Búm to Disang River.	I. Melankha, on U'rúp.
10.	Thence to Sumbogan, Singphu village.	J. To small stream ; long march.
11.	Thence to Hukong short march.	K. To Bamo, a long march.
	Eleven stages to Hukong.	Eleven stages to Bamo.

EXTRACT FROM ASSAM BOUMJI RELATING TO PATKAI.

(History of the Kings of Assam, p. 13.)

এনেতে আমার কালর ত্যাতান্ বিঙ্গ বর গোঁহাই বাহি সে পাট্‌কাইতে দুয়ো দলে মিলামিলি হল। পাছে দুয়ো কালর রাজ আজ্ঞারে দুয়ো দলে পাট্‌কাইর ওপররনঙ্গ এতাঙ্গ পানিতে হাত জোবরাই, এবং কুকুরাকো কাটী সপত কির লাক্লি ডাকমাও ১৩২৩ সঁকত পাট্‌কাই পর্ব্বতকে সিমা করি দুয়ো বর গোহাঁইর দুটা মুর্ত্তি সিলতে কটালে। নঙ্গ এতাঙ্গর অর্থ এই, নঙ্গ বিল, এতাঙ্গ আছে। আরু বুলিলে বোলে, এই পর্ব্বতকে আমি সিমা করিলো; এতেকে দুইরো মুর্ত্তি এই চিন থাকিব, আরু এই সিমা এরি কোনেও বাহি কোনো কাললৈ আক্রমণ করিব নেপাই। এই রূপে মিলামিলি করি সিমা পাতি উভয়েই আপন ঠায়ে ২ গল। পাট্‌কাই পর্ব্বতক চুকাফা রজা দেও-অসম দেসলৈ অহা কালত ডইকাউরঙ্গ বুলিচিলে। তার অর্থ এই, ডই পর্ব্বত কাউ ৯ টা, রঙ্গগোট খোয়া। পাছে এই সিমা করার পরা পাট্‌কাই চেঙ্গকান বুলিলে; পাচলৈ কেবল পাট্‌কাই নামহে জলিল। ঐ পাট্‌কাই চেঙ্গকানর অর্থ এই, পাট কাটি, কাইঃকুকুরা, চেঙ্গঃসপত, কানঃলগালে, সেই ঠাইতে।

VIII.—*On a new Standard of Light.—By* Louis Schwendler.

(With Plate VIII.)

No exact measurement of any quantity, even with the most accurate and sensitive Test-methods available, can reasonably be expected unless the standard by which the unknown quantity is to be gauged is perfectly *constant* in itself; or, if nature does not permit of such a desirable state of things, the causes to which the variation of the standard are due, should be known, and in addition also their quantitative effect on the standard, in order to be able to introduce a correction whenever accuracy of measurement should permit and circumstances necessitate it.

This requirement for a standard necessarily entails on the one hand a knowledge of the relations which exist between the standard and the causes of its variation, and on the other hand the possibility of an accurate and independent measurement of these causes.

Further, having no constant standard, it is impossible to produce two quantities of the same kind bearing a fixed and known ratio to each other. Consequently, no idea can be formed of the accuracy of the test-method adopted, and if such is impossible we are also unable to improve the test-method in itself, *i. e.*, with respect both to accuracy and sensitiveness.

The inconstancy of a standard acts, therefore, perniciously in two directions: it prevents us from being able to execute accurate measurements even with the most accurate and sensitive test-methods, supposing such are available; and further leaves us in that deplorable condition of not being able to improve the test-method, although we may be convinced that the method of testing requires such improvement.

It may be safely asserted that in any of the branches of the physical sciences, where constant standards do not exist, the progress in accurate knowledge of nature must be slow, if not impossible.

This train of thought will, I think, invariably beset the physicist who endeavours to make Photometric measurements.

Recent experiments on the value of the electric light as compared with the ordinary means of illumination,* called my attention forcibly to this point.

* These experiments I had to institute on behalf of the Board of Directors of the East Indian Railway Company, under orders of the Secretary of State for India, to enquire into the feasibility and practicability of lighting up Indian Railway Stations by the Electric Light.

Old Standards for Light Measurements.—Up to the present in England the *Standard Candle** has been adopted as the standard of light, the unit of light being defined as that light which the said candle emits when burning steadily at a certain definite rate. In France the *Carcel Burner* (Bec Carcel) has been introduced as the standard of light. The unit of light in this case being defined as that light which emanates from a good moderator lamp burning pure colza oil, at a given definite rate. The ratio of these two arbitrary units, is given by several authorities very differently, the mean value being about :—

10 Standard Candles = 1 Carcel Burner.

These two standards of light, although answering perhaps certain practical requirements, are by their nature ill-adapted to form the units of light intensities. A good and trustworthy standard should possess absolute constancy, or if not, should afford the possibility of application of a correction for the variation and, moreover, should be capable of accurate reproduction. These qualifications are certainly not possessed by the standards at present in use.

A candle of whatever compound and size will partake of something of the nature of a complex body, an accurate reproduction of which must always be a matter of great difficulty. Exactly the same holds good for the Carcel Burner.

Further the amount of light these standards produce, depends to a very considerable extent on external influences, which do not allow of easy control or measurement, and which therefore cause variations in the standard light for which it becomes impossible to introduce a correction. For instance, the rate and regularity with which a candle burns and the amount of light it gives, depend, in addition to the material of which the candle consists, on the ready and regular access of oxygen. In a closed up place, like the box of a photometer, if the draught is not well regulated or the supply of fresh air not quite constant, it can be easily observed that the very same candle may emit light at different times varying as much as 50 per cent. Another difficulty is introduced by the variation of the length of the wick, and of the candle itself, by which the standard light necessarily alters its position in the photometer and consequently its quantitative

* The Metropolitan Gas Act 1860 (23 and 24 Vict. Cap. 125, Sec. XXV) defines the standard candle as :—

"Sperm candles of 6 to the pound each burning 120 grains an hour." I have tried the standard candles as made by two different manufacturers, Messrs. Field and Co. and Mr. Sugg. These candles are sold as six to the pound, and consume according to my own experiments about 8.26 Gm per hour when placed in a large room and direct draughts excluded.

effect on a given point. These difficulties might be overcome to a certain extent by mechanical means; as, for instance, by cutting the wick automatically within equal and short intervals of time, and by placing the candle in a closely fitting metal-tube, against the top rim of which a spring presses the burning candle, in fact a similar construction to that used for carriage candles. But to say the least, all such arrangements are cumbersome. Without going into further details with reference to the Carcel Burner, it may be said that the disadvantages of this standard are at least equally great. In fact it appeared to me that the production of a standard light by combustion is not the right method; the flame resembles too much organic life with its complex and incessantly varying nature. Gauging mechanical force by the power a particular horse of a certain breed is able to exert, can scarcely be called a less scientific standard, than the combustion standard for measuring light. Under these circumstances, I thought it best to leave the old track, and produce the standard of light, *by the heating effect a constant current has, in passing through a conductor of given mass and dimensions.**

New Standard of Light.—Several Platinum Photometric Standards were made and tried. If the current passing through the platinum was kept constant, the light produced was also constant, and for the same current and the same platinum standard, the light was always of the same intensity, under whatever other circumstances the experiments were conducted.

Platinum evidently is the best metal which can be chosen, for it does not change in contact with oxygen; it can be procured very pure and its melting point is high enough to allow an intense light.

It is probable that at a high temperature platinum becomes volatilized, but this process can only be exceedingly slow, and therefore the light produced by a standard, cannot alter perceptibly in time. To make the light constant from the moment the current passes, *i. e.*, to establish dynamic

* The idea of using the light produced by a conductor through which a strong current passes, as the unit of light, appeared to me so natural and simple, that I could scarcely understand why it had not been proposed and acted upon before.

I could however find nothing on the subject anywhere, until lately my attention was called to a small pamphlet written by Zöllner in 1859 in which the same idea occurs:

In the preface to his Inaugural Dissertation, Zöllner says:—

"andererseits aber auch zu zeigen, dass ein galvanisch glühender Platindraht von "den bis jetzt bekannten Lichtquellen zur Aufstellung einer photometrischen Ein-"heit, trotz mancher practischer Schwierigkeiten, vielleicht dennoch das geeignetste "Mittel sei."

I have since learnt that Dr. Draper, as early as 1844, proposed a "unit lamp" consisting of a platinum strip heated by an electric current.

equilibrium between the heat produced and the heat lost per unit of time, it is necessary to make the arrangement in such a manner, that the electric resistance offered by the standard is only in the piece of platinum, intended to be made hot by the current, and not in the other parts of the circuit.

For this reason I find it best to cut the piece of platinum out of a platinum sheet.

Figure 1, Plate VIII gives the form in actual size. The two ears, left white in the drawing, may then conveniently form the electrodes between the leading wires and the piece of U-shaped platinum which has to produce the light. As the U-shaped portion is left in its natural connection with the ears, the contact takes place over a large surface, and therefore the contact resistance must be small. This special form, if the dimensions are defined as well as the weight of the platinum sheet, out of which it is cut, can be easily reproduced anywhere. Further it is required to exclude the draught from the heated platinum. This is best done by putting on a cover of thin white glass. One half of it is left white, the other half is blackened on the inside. This precaution is required in order to insure that light emanating from one side only of the platinum is used in the photometer.

Otherwise light from the back part of the heated platinum, would be reflected into the photometer. This part is unknown and could therefore not be taken into account when measuring the light emanating from one side of another light. In fact to be able to form right conclusions from Photometric measurements, it is necessary to arrange the experiment in such a manner that either the two lights under comparison throw the same fraction of the total light into the Photometer, or if this is impossible, to ascertain this proportion accurately.

The Platinum Standard light (PSL), described before, we will call in future A. Sending a current of 6.15 webers through it (15° deflection on my large Tangent Galvanometer, for which the constant = 2.296 C. G. S.), the PSL (A) produces a light equal to 0.69 Sugg's candle, or,

1 Sugg's candle = 1.44 PSL (A) with
6.15 webers.

Hence, if this particular light were adopted as the unit, we might define it as follows :—

6.15 webers passing through a piece of Platinum 2 mm. broad, 36.28 mm. long and 0.017 mm. thick, weighing 0.0264 Gm., having a calculated resistance = 0.109 S. U., and a measured resistance = 0.143 S. U. at 66° F. gives the unit for light intensity.*

* In order to show that a platinum light standard can easily be reproduced, I will give here some actual measurements :—

The Platinum sheet out of which the P. S. L. (A) was cut weighed 0.0364 Gm. per square centimetre. From this the weight of the part which becomes hot calculated,

Photometric Measurements. Having now a constant light it became possible to measure the variations of light which the combustion standards invariably show.

For instance one of Sugg's Candles was compared with the P. S. L. (A) with the result shown in the following table :—

Distance in Millimetres.		Remarks.
P. S. L. (A) with 6.15 webers.	Sugg's candle.	
100 mm.	117 mm.	The P. S. L. (A) was kept at the same position = 100 mm.
These readings were taken in about five minutes.	120	
	112	Sugg's candle was moved in order to get the light equal.
	110	
	120	The variations observed were actually in the candle and not in the Platinum standard, as the eye could easily discern.
	120	
	120	
	120	
	126	
	128	
	117	
	120	
	123	
	127	

This gives as an average :—

1 Sugg's Candle = 1.44 P. S. L. (A) with 6.15 webers.

$\frac{\text{Max}:}{\text{Min}:} = \frac{1.64}{1.21}$, or total variation of the candle about 30 per cent. from the average in the very short interval of time of about five minutes. This needs no further comment. Some additional experiments were made in order to ascertain the variation of the light of a standard candle.

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gives 0.0264 Gm. The resistance of the standard, measured at 66° F., gave 0.143 S. U., including contact resistances.

Now another piece of Platinum sheet 26 × 28 mm. was found to weigh 0.265 Gm. The piece cut off which actually becomes hot = 0.026 Gm., which agrees within 0.0004 Gm., with the weight found by calculation for the P. S. L. (A) actually used.

$$\left.\begin{array}{lr} \text{Taking the specific resistance of Mercury} & = 96190 \\ \text{of Platinum annealed} & = 9158 \end{array}\right\} \text{at } 0^\circ \text{ C.}$$

$$\left.\begin{array}{lr} \text{the calculated resistance of the Platinum which becomes hot} & = 0.109 \\ \text{Measured resistance, including contact resistance} & = 0.143 \end{array}\right\} \text{S. U. at } 66^\circ \text{ F.}$$

or contact resistance probably = 0.034 S. U.

It is therefore much more accurate to define the P. S. L. by weight, than by resistance.

The P. S. L. (B)* with a current = 5.9 webers was used as unit.

1*st Candle,* 7 readings in 10 minutes

$$\text{mean} = 1.08 \text{ P. S. L. (B)}$$

$$\frac{\text{max}:}{\text{min}:} = \frac{1.19}{1.00} \text{ or total variation} = 17.6 \text{ per cent.}$$

The maximum was obtained directly after having opened the Photometer when fresh air entered.

2*nd Candle,* 10 readings in 14 minutes

$$\text{mean} = 1.07 \text{ P. S. L. (B)}$$

$$\frac{\text{max}:}{\text{min}:} = \frac{1.32}{0.69} \text{ or total variation} = 59 \text{ per cent.}$$

The minimum was obtained directly after freshly lighting the candle.

3*rd Candle,* 12 readings in 24 minutes

$$\text{mean} = 1.07 \text{ P. S. L. (B)}$$

$$\frac{\text{max}:}{\text{min}:} = \frac{1.30}{0.81} \text{ or total variation} = 46 \text{ per cent.}$$

The lowest reading was obtained shortly after lighting the candle.

4*th Candle,* 14 readings in 22 minutes

$$\text{mean} = 0.94 \text{ P. S. L. (B)}$$

$$\frac{\text{max}:}{\text{min}:} = \frac{1.26}{0.58} \text{ or total variation} = 72 \text{ per cent.}$$

The lowest reading cannot be accounted for.

Two new Platinum Light Standards of the same form and size as the P. L. S. (A) described before, were placed in circuit of 8 Grove's cells connected up successively and with a Mercury Rheostat in circuit, to keep the needle of the Tangent Galvanometer at a constant deflection.

These two new P. L. S., called II and III, were placed in the Photometer to compare their lights and by it test the accuracy of the Photometer readings, and other influences to be named further on. (see fig. 2, Plate VIII.)

$$d + d' = \text{D} = 250 \text{ mm (constant)}.$$

Light i produced by P. L. S. (III), Light i' produced by P. L. S. (II). The balance between the two lights being obtained by moving the prisms within that fixed distance. A piece of red glass was used for taking the readings.

* This Platinum standard (B) was the first made, and has a different form from the other (A) described: Dimensions and weight cannot be accurately given now.

In the following table the results are given :—

No. of Experiment.	P. L. S. II producing i^1 d^1 mm from Prism.	P. L. S. III producing i d mm from Prism.	Deflection on Tangent Galvanometer.	$\frac{i^1}{i}$	Remarks and particulars.
1	100	150	18.8		Both lights having glass covers, but glasses were quite clear.
	100	150	18.8		
	100	150	18.8		
	100	150	18.8		
	100	150	18.8		
	99	151			
	100	150			
1	99.86	150.14	18.8	0.44	
2	103	147	18.8		A clear glass cover on No. III; no glass cover on No. II.
	102	148	18.8		
	102	148			
	103	147			
	102	148			
2	102.4	147·6.	18.8	0.48	
3	98	152	18.8		A clear glass cover on No. II; no glass cover on No. III.
	97	153	18.8		
	98	152	18.8		
	98	152			
	98	152			
	99	151			
	98	152			
3	98	152	18.8	0.42	
4	98	152	18.8		A glass cover on No. III, the back of it covered inside with black paper; a clear glass cover on No. II.
	98	152	18.8		
	99	151	18.8		
	100	150	18.8		
	100	150			
	98	152			
4	98.83	151.17	18.8	0.43	
5	101	149	18.8		Both lights covered up with glass covers, each glass cover having inside a black paper.
	101	149	18.8		
	102	148	18.8		
	101	149			
	101	149			
5	101.2	148.8	18.8	0.46	

No. of Experiment.	P. L. S. II producing i^1 d^1 mm from Prism.	P. L. S. III producing i d mm from Prism.	Deflection on Tangent Galvanometer.	$\frac{i^1}{i}$	Remarks and particulars.
6	103 101 101 101 101 101	147 149 149 149 149 149	21.0 21.0 21·0 21.0 21.0		Current increased by decreasing the resistance of the Mercury Rheostat, but kept constant at 21°. Clear glass again on both like experiment No. 1.
6	101.3	148.7	21.0	0.46	
7	104 103 102 102 102	146 147 148 148 148	21 21 21 21 21 21		Clear glass cover on No. III. No glass cover on No. II.
7	102.6	147.4	21	0.48	
8	101 100 100 99 100 100 100	149 150 150 151 150 150 150	21 21 21 21		Clear glass cover on No. II. No glass cover on No. III.
8	100	150	21	0.44	
9	101 101 101	149 149 149	21 21 21		Both the clear glass covers on.
9	101	149	21	0.46	

The Deflection 18.8° represents a current = 7.82 webers.

The Deflection 21.0 represents a current = 8.81 webers.

From these results the following conclusions can be drawn :—

The thin glass covers, as was to be expected, absorb a measurable quantity of light. Compare the results of experiments Nos. 1, 2 and 3, and of 6, 7, 8 and 9.

Covering the glass covers inside with black paper to avoid back-

reflection, appears to weaken the light, as was to be expected. Compare the results of experiments Nos. 1, 4 and 5.

The ratio $\frac{i^1}{i}$ of the two lights is independent of the strength of the current, which it ought to be.

These results, although showing nothing extraordinary, *i. e.*, what could not have been foretold without making the experiments, are nevertheless valuable, since they prove that in the first instance thin glass covers take away very little light, and that back-reflection is also very little; but small as these influences are, they have been unerringly measured by the Photometer, showing this instrument to be very accurate and the eye quite trustworthy. That the light i produced by P. L. S. III was so much more intense than i^1 produced by P. L. S. II., is due to the fact that the Platinum sheet out of which No. II. was cut was much thicker than the other.

Detailed description of the Standard and the method of using it.

Fig. 3, Plate VIII. gives the construction of the Platinum standard in half its natural size. I need not give further explanation on this point as everything will be readily understood from the drawing.

Fig. 4 shows the diagram of the connections.

P. L. S. is the standard—

G a current indicator, or better, current measurer. The deflecting ring must consist of a few convolutions of thick copper wire—of no perceptible resistance. The small magnet needle is best to be pivoted, carrying a long aluminium index.

E is the battery, consisting of a few elements of high E. M. F. and low internal resistance connected up successively. Grove's, Bunsen's or large Daniell's cells will answer well for the purpose.

(1) is a stopper by which the circuit can be conveniently opened or closed.

M is a mercury rheostat of about one unit resistance. A groove of about 1 mm. section and 1 metre total length is cut into hard wood (not ebonite, as mercury does not run well in ebonite). The hard wooden board is supported by three levelling screws.

Further the mercury is in perfect metallic contact with two iron terminals *f f*. These terminals are not to be fixed to the board. They are simply placed into the mercury, which fills small reservoirs at each end of the mercury thread.

The resistance of the mercury rheostat can be easily altered by moving the bridge *b* along the two parallel mercury grooves. If the bridge is taken out, the total resistance of the rheostat is in circuit.

If the bridge b is close to the two terminals f f, the resistance of the rheostat is nil.

This range of resistance with about 6 to 10 volts will prove sufficient to make the current strong enough and to keep it constant for many hours, especially if the precaution is taken to open the circuit when no light is required. The bridge b consists of a strip of copper at least 2 cm. broad and 1 mm. thick. The knife edges which dip into the mercury are amalgamated.

The current measurer G has been gauged by comparison with a standard tangent galvanometer; so that the currents indicated by certain deflections of the needle are correctly known in absolute measure.

Whenever a Photometric measurement is made the current is adjusted to its defined strength, *i. e.*, the given known deflection is procured by moving the copper bridge b.

If the instrument G is well constructed, this adjustment of current strength can be executed as accurately as weight measurement by a chemical balance.

Correction for the Standard.

Although with the above arrangement it will be always possible to keep the current constant and up to its defined amount, it might nevertheless happen under particular circumstances that the current producing the light has been rendered different from the current for which the standard has been defined.

In this case the following correction can be applied:—

$$\iota = \frac{1}{(1 + a)\left(\frac{c}{\gamma}\right)^2 - a}$$

where c is the current for which the intensity of the light has been defined as unity.

γ the actually observed current, and a the co-efficient for platinum which gives the percentage variation of resistance for high temp, 1500°-2000° F. for 1° Celsius.

This correction has been developed under the supposition that the light produced in the given piece of platinum is proportional to the work done by the current through the resistance of the platinum, and that, further, temperature and light are proportional. These suppositions are almost correct for small variations of the current.

In conclusion it may be stated that it was ascertained that the Platinum Light Standard (B) produced the unit intensity of light, (the unit of light equal to the light emitted by the Standard Candle) at a total expenditure of energy equal to 427 Ω ergs per second. Of these, 300 Ω ergs were actually transformed into light by heating the platinum up to a high temperature; while the remaining 127 Ω ergs were lost for illuminating purposes, being used for raising the temperature of the circuit exclusive of the Platinum Standard.

The Platinum Light Standard (A) being made of much thicker platinum sheet, showed a much less favourable result. The unit of light by (A) was produced at a total expenditure of energy equal to 1226 Ω ergs per second, of which 725 Ω ergs were actually transformed into light, the remaining 501 Ω ergs were wasted in heating the circuit to low temperature (no light). Considering that the unit of light can be produced in an electric arc at a total expenditure of energy of 10 Ω ergs per second only (see my *Précis of Report on Electric Light Experiments*, London, 1st Nov. 1878, p. 11), when produced by Siemens's intermediate Dynamo-Electric Machine, it follows that from an engineering point of view, light by *incandescence* can scarcely be expected to compete with light by *disintegration* (electric arc).

In fact, it appears that light by *incandescence* is scarcely any cheaper than light by *combustion.* The reason for this is that the temperature of an incandescent platinum wire is not very much higher than the temperature of a flame, and that for unit volume the mass which has to be kept up heated in a piece of platinum is much larger than the mass in a flame. Unless we should be fortunate enough to discover a conductor of electricity with a much higher melting point than platinum, and that the specific weight and specific heat of that conductor is also much lower than for platinum—and that at the same time the new conductor does not combine at high temperatures with oxygen, we can scarcely expect that the principle of incandescence will be made use of for practical illumination.

Further it was ascertained that the resistances of the platinum light standards (not including constant resistance) were as follows:—

P. L. S. (B) = 0·136 Ohm at 22·2° C.
= 0·876 „ at the temperature of the standard,

where the light was measured, or increase $\frac{0{\cdot}876}{0{\cdot}136} = 6{\cdot}44$.

P. L. S. (A) = 0·102 Ohm at 18-9° C.
= 0·964, „ at the temperature of the standard,

where the light was produced, or increase $\frac{0{\cdot}964}{0{\cdot}102} = 9{\cdot}45$.

I regret that I have not been able to calculate from the above results the temperature of the heated platinum, since I could not procure in time a copy of Dr. William Siemen's Bakerian Lecture (1871), which at present, to my knowledge, is the only source where the increase of resistance of platinum at high temperatures can be found.

To sum up :—

The advantages of the new standard of light are :—The light is perfectly constant if the current be kept constant ; it allows a correction to be made for the variation of the current if this variation is known ; it can be reproduced accurately everywhere if ordinary precautions be taken to secure pure platinum ;* its magnitude can be altered to any extent to suit certain practical purposes by simply varying the elements of weight, shape, and size of the platinum, or the strength of the current passing through it ; it does not alter of itself either in intensity, size, or position, and therefore by it most accurate photometric measurements can be executed ; the standard can be easily made to fit into any adopted system of absolute units. Hence the new standard fulfils *all* the recognised conditions of a perfect and rational standard, and therefore it would be advisable to adopt it in future, as the practical standard for light-measurement. There would be no practical difficulties met with in the introduction of the new standard for technical purposes.

* The conductivity of any metal is much lowered by slight impurities, and platinum does not form an exception. Hence great care must be exercised in the selection of platinum for the light standard. Dr. William Siemens in his Bakerian lecture says : " The abnormal resistance of some platinum is due chiefly to the admixture of iridium or other metals of the same group, and it appears that platinum prepared by the old welding process is purer and therefore better suited for electrical purposes than the metal consolidated by fusion in a Deville furnace."

IX.—*A second note on* Mammalia *collected by Major Biddulph in Gilgit.*—*By* W. T. Blanford, F. R. S., &c.

(Received and read May 7th, 1879.)

In the Journal of the Society for 1877, (Vol. XLVI, Pt. 2, p. 323,) I gave a brief note of some mammalian skins sent by Major Biddulph from Gilgit, comprising a fox, an otter, a mouse, a hare and a *Lagomys.* Another small collection has since been forwarded to the Indian Museum by the same officer. This is even more interesting than the last, for two of the species belong to a genus, *Cricetus*, not previously found in the valley of the Indus, although widely distributed in Central Asia. At the same time a rat is sent that is undistinguishable from a common Indian species. The other skins belong to a mouse and to two species of fox. On each of these I will add a few notes.

1 and 2. *Vulpes*, 2 sp. Two fox skins sent by Captain Biddulph are very difficult to determine. The larger is an animal apparently about the size of *Vulpes montana*, but darker in colour and much less rufous. The dark colour, so far as is it due to the black tips of the longer hairs, may perhaps vary with age, but it is in great measure caused by the under-fur, which differs from that of *V. montana* in being more dusky, and especially in being brown at the extremity instead of bright rufous. The ears are sooty outside instead of black, and the throat is not so dark a grey as in Simla specimens of *V. montana*, but these differences are not of much importance.

There is a well marked distinctive character in the skull of the two types. The brain-pan in the Gilgit fox is broader and higher, and the occipital portion in consequence differently shaped. The lower jaws too are somewhat different.

The following is a description of the skin, which was evidently procured in winter.

General colour dusky fulvous, the colour being much darker in consequence of the under-fur shewing through; there is a slight rufous tinge on the back caused by the extremities of the long hairs being tinged with red; lower parts dusky grey, outside of limbs and of ears sooty black, margins of ear covered with dense short hairs of a creamy white or pale buff colour; face pale rufous, darker in front of the eye, with a brown patch before each eye. Whiskers black. Tail tip wanting, the basal portion pale fulvous, with black tips to the long hairs. Hairs of back of neck and of flanks also black tipped. The under-fur on the back very long and woolly, of a brownish grey colour, paler at the base. Ends of the longer hairs very pale fulvous.

Feet thickly covered with brown hair beneath, so that the toe pads are almost concealed. Hind foot and tarsus nearly 6 inches long.

The following are comparative measurements in inches of the skull with that of a ♀ *V. montana* from Simla.

	Gilgit fox.	*V. montana.*
Length from base of foramen magnum to end of premaxillaries,	4·85	4·92
Breadth across zygomatic arches,	2·92	2·83
Ditto of brain-pan where widest,	1·97	1·76
Height of ditto from lowest part of auditory bullæ,	2·05	1·8
Breadth of cranium behind postorbital processes,	0·9	0·78
Breadth across postorbital processes,	1·25	1·23
Length of suture between nasals,	1·73	1·75
Ditto of bony palate from opening of posterior nares to end of premaxillaries,	2·68	2·75
Length of mandible from angle to symphysis,	3·94	4·
Height ditto from angle to coronoid process,	1·41	1·45

In form there is much resemblance between the skull of the Gilgit fox and that of a species of which the Museum possesses numerous specimens brought from Afghanistan, but said by the man from whom they were purchased to be from Bokhara.

The other fox is a very pale-coloured animal closely resembling the type of the Afghan *V. griffithi** in colour, except that the back is rather more rufous and there is a want of the black tips to the hair on the back of the neck. These differences may be due to age. The skull is smaller and the muzzle distorted. The face, front of the fore legs, outside of the hind legs, and back are rusty red, the latter dusky from the admixture of black tipped hairs. Ears sooty black. Under-fur grey with a pinkish tinge.

I believe this animal is a variety of *V. griffithi*, the small fox of Afghanistan. The larger fox I am unable to determine satisfactorily. It is allied to *V. montana*, and *V. flavescens*, and should be compared with *V. melanotus*,† or at least with the animal usually thus designated by Russian naturalists.‡

3 and 4. *Cricetus (Cricetulus) phæus*§ and *C. (Cricetulus) fulvus.*||

* Blyth, J. A. S. B., 1854, XXIII, p. 730, and 1845, XIV, p. 344.

† *Canis melanotus*, Pall., Zoog. Ros. As., Vol. i, p. 44, identified by Gray with *Canis karagan*, Erxleben.

‡ *E. g.*, Severtzoff. Turkestanskie Jevotnie, p. 61;—Ann. Mag. Nat. Hist., July 1876, Ser. 4, XVIII, p. 48.

§ Pallas, *Glires*, pp. 74, 261, Pl. XVA.

|| W. Blanf., J. A. S. B., 1875, XLIV, Pt. 2, p. 108; Scientific Results, 2nd Yarkand Mission, *Mammalia*, p. 45, Pls. IX, X *b*.

Of the former of these species three skins have been sent by Major Biddulph, of the latter two. They thoroughly confirm the distinction between the two species, the first named being smaller and much greyer, the latter larger and more rufous. There is a corresponding difference in the size of the skulls, though very little in form; that of *C. fulvus* measures 1·17 inches long by 0·64 broad, and that of *C. phæus* 0·94 by ·48. *C. fulvus* probably weighs at least twice as much as *C. phæus*. The tail is much thicker in the former than in the latter.

5. *Mus erythronotus*.* There are, amongst the Gilgit skins, two specimens of a slightly rufescent white-bellied mouse, with rather a long tail. This mouse, like the *Criceti*, is evidently the same as a species of which specimens were brought by Dr. Stoliczka from Wakhán in the upper Oxus valley in 1874. I was at first disposed to identify this mouse with the European *M. sylvaticus*, but there are, I find, differences in the skulls; the occipital portion and the foramen magnum in the European species being higher in proportion to the breadth, whilst the opening of the posterior nares is much narrower, the breadth being less than that of the anterior upper molar, whilst in the Wakhán skull the breadth exceeds that of the molar. In *Mus sylvaticus*, the hinder upper molar is only about a fourth of the size of the second molar, whilst in the Wakhán and Gilgit skulls the third molar is about half the size of the second. In the form of the occiput the skulls from Wakhán and Gilgit agree with the figure of the type of *M. erythronotus*, the specimens of which belonging to the Indian Museum appear unfortunately to have been mislaid. The comparison is imperfect, and it is far from improbable, with a good series of specimens, that all these races would be found to grade into typical *M. sylvaticus*, of which, it should be said, only a single skull is available for comparison.

The important fact is, however, that of the small number of rodents hitherto detected in Wakhán and Gilgit respectively, three, a mouse and two *Criceti*, are identical, and that consequently part of the fauna of the Gilgit portion of the Indus valley differs from that of Ladák so far as known, and agrees with that of the upper Oxus.

Compared with the figure of *M. erythronotus*, the Wakhán and Gilgit mouse is rather less rufous, and the tail in the latter is distinctly dark brown above and pale below.

6. *Mus rufescens*, auct. The last specimen sent is perhaps the most remarkable of all, for it is a white-bellied, long-tailed rat of moderate size, quite undistinguishable, so far as I can see, from specimens of the common

* W. Blanf., Eastern Persia, II, p. 54, Pl. V, fig. 3.

tree-rat of India, called *Mus rufescens* by Blyth* and Jerdon,† but greyer and less rufous than that species generally is. The skull is undistinguishable from that of Calcutta specimens. The dried skin measures about 5½ inches from nose to insertion of tail, tail (vertebræ preserved) 6 inches. The colour is greyish brown above, darker on the back owing to the prevalence of longer black-tipped hairs, white below, the edge of the white colour being distinct and well marked.

This rat is found in most parts of India, and *M. robustulus*,‡ of Burma appears to be only a variety. It also abounds in the Nicobar islands where it does much damage in the cocoa-nut trees.§ It is naturally surprising to find this rat in the upper Indus valley together with Central Asiatic types like *Cricetus* and *Lagomys*. Of course I do not mean to say that this long-tailed Indian tree-rat is true *Mus rufescens* of Gray, but the determination of the names of Indian rats and mice can only be attempted after a careful comparison of specimens.

X.—*A Description of some new Species of Hydroid Zoophytes from the Indian Coasts and Seas.*—*By* SURGEON J. ARMSTRONG, *Marine Survey Department.*

(Received 7th May;—read 4th June, 1879.)

(With Plates IX, X, XI, XII.)

With the exception of a single species all the following hydroids are calyptoblastic. The one exception is *Endendrium ramosum*, which is a typical gymnoblastic zoophyte, and is especially remarkable in having the gonophores borne not upon a true blastostyle but upon atrophied hydranths from which the tentacles have disappeared.

LAFOËA ELONGATA, (nov. spec.)

(Plate IX.)

Zoophyte.—Plant-like, gregarious, dark-brown.

Trophosome.—Stems erect, simple, straight or slightly curved, 1 to 2¼ inches high, pinnate, with 3 or 4 transverse annular markings immediately above the origin of each pinna, and rooted by a creeping tubular

* J. A. S. B., 1863, XXXII, p. 340.

† Mammals of India, p. 199.

‡ Blyth, J. A. S. B., XXVIII, p. 294; XXXII, p. 342; see also J. A. S. B., 1878, XLVII, pt. 2, p. 165.

§ Stray Feathers, IV, p. 433.

stolon. The pinnæ are alternate, and each carries on its upper surface a monoserial row of hydrothecæ, they are transversely annulated, both at their origins from the stem and immediately above the origin of each calycle. The hydrothecæ are free, elongated and tubular, annulated at their origins, and with the margin of the mouth even.

Gonosome.—Unknown.

Habitat.—Rocks between high and low water at Pigeon Island, and Konkan Coast on the west coast of India, and at Diamond Island off the Pegu Coast in Burmah.

This very interesting form is certainly a campanularian, while its long tubular hydrothecæ would indicate *Lafoëa* as its proper genus, a genus, however, not very well defined. I have lately had several opportunities of examining this zoophyte in a living condition; the polypites are supported on long attenuated peduncles, and have both disc and tentacles completely extruded from the hydrothecæ, into the cavities of which they are only partially retractile. Although apparently tolerably extended in its distribution, it is very far from being abundant anywhere. It seems to thrive best in those localities most exposed to heavy seas and the influence of the South West Monsoon. This species and another belonging to the genus *Thimaria* are the only representatives of the Hydroid family I have met with during two seasons spent upon the coast of the Ratnágiri and Alíbág Collectorates.

HALICORNARIA SETOSA (nov. spec.)

(Plate X.)

Zoophyte.—Stiff, erect, solitary, and of a dark-brown colour.

Trophosome.—Stem bipinnate, more or less irregularly and numerously branched, varying in height from one to five inches, rooted by an entangled mass of short fibrous filaments, and carrying closely set primary pinnæ. The main stem is made up of a fasciculus of three tubes, from the central one of which an alternate series of hydrotheca-bearing pinnæ arises, but the stems of the secondary pinnæ, which are formed of a fasciculus of two tubes, are destitute of hydrothecæ, but carry along their entire length an alternate series of ultimate hydrotheca-bearing pinnæ. The ultimate pinnæ are thus borne not only on the primary pinnæ but also on the stem; they are closely set, alternate, of nearly equal length, and divided by joints into a series of internodes, each of which gives origin to a calycle with its nematophores. The hydrothecæ are deep, flask-shaped, deeply concave in front below the lip, and correspondingly convex behind; the aperture is wide, and has the margin provided with two large lateral teeth, and two smaller ones posteriorly. The

nematophores are three in number, two lateral, which are short, blunt, divergent, and projecting slightly beyond the margin of the hydrotheca; and one mesial, which is remarkable as being provided with a lateral as well as terminal orifice, it is adnate to the base and lower third of the calycle, being free only at its extremity which projects horizontally outwards from the hydrotheca.

Gonosome.—Consists of a number of lozenge-shaped bodies filled with dark granular matter, and pointed at their free extremities; they arise on each side of the primary pinnæ in the intervals between the ultimate pinnæ.

Habitat.—Off Cape Negrais in 80 fathoms. At Cheduba Island in from 8 to 10 fathoms; off the Terrible Islands in 25 fathoms, and off Cape Comorin in 40 fathoms.

This beautiful species is closely allied to *Halicornaria bipinnata* of Allman. It has a very wide distribution, being found at intervals all along the Arrakan and Pegu Coasts, as well as off the South Coast of India. On several specimens which I examined I found the main stem provided with two parallel rows of pellucid dots, the nature of which I have hitherto been unable to determine; they are, however, most probably the optical expression of cauline nematophores. It is also remarkable in having the mesial hydrothecal nematophore provided with a lateral orifice as in *H. saccaria* (Linn. Soc. Journ., Vol. XII.) This species appears to afford a favourite anchoring ground for a small bivalve belonging to the genus "*Vexillum*;" most of the specimens dredged up by me were covered with this species firmly adherent by their byssi and in different stages of development.

Halicornaria plumosa (nov. spec.)

(Plate XI.)

Zoophyte.—Feathery, gregarious.

Trophosome.—Stems one to two inches in height, fascicled towards the base, of a dark brown colour, straight or gently curved, minutely pinnate and rooted by a creeping filiform stolon. The pinnæ arise alternately by jointed processes from the anterior surface of the stem; they are divided by more or less complete joints into a series of short internodes, each of which carries a calycle with its nematophores. The hydrothecæ are unilateral and borne on the upper surface of the pinnæ and sessile; they are cup-shaped and have a large and patulous orifice, the margin of which is deeply denticulated, and is especially characterized by the possession of a single long mesial tooth immediately behind and projecting above the anterior nematophore. The intrathecal ridge passes backwards

from the anterior nematophore across the lower fifth of the calycle and is prolonged into the wall of the pinna. The nematophores are only developed in connection with the hydrothecæ, they are three in number, two lateral and one mesial or anterior; the lateral are short, tubular, free and projecting; the mesial is long, adnate throughout its entire length, except at its immediate extremity, where it is free and slightly projecting.

Gonosome.—The gonothecæ arise singly from the posterior aspect of the stem near its base, they are bell-shaped and have a circular even and somewhat everted margin; the older ones present a more or less annulated or ribbed appearance.

Habitat.—In 35 to 40 fathoms off Cape Comorin, south coast of India, and in from 10 to 15 fathoms off Cheduba Island, coast of Arrakan.

Desmoscyphus humilis (nov. spec.)

(Plate IX.)

Trophosome.—Stems gregarious, not exceeding a quarter of an inch in height, straight, simple, erect, divided by joints into a series of short internodes, each of which carries a pair of calycles, and rooted by a creeping stolon. The hydrothecæ are biserial, opposite, urceolate, the upper half free and tubular, the lower half adnate and sacciform; the aperture is directed upwards and outwards, and has the margin marked by several deep denticulations.

Gonosome.—The gonothecæ are broadly tubular or slightly pyriform and with a simple margin; they are opposite, and arise by short pedicles on each side in the intervals between the calycles with which they consequently alternate.

Habitat.—Saint George's Island on the west coast of India, attached to sea-weed between high and low water marks. This species is evidently referrible to the genus *Desmoscyphus* of Allman. (Linn. Soc. Journal, Vol. XII.) Although many gonangia possess clearly defined peduncles, yet at first sight some often appear to be sessile. This difference, however, is only apparent, for a closer examination shows that they are all pedunculated.

Sertularella rigosa (nov. spec.)

(Plate X.)

Trophosome.—Stems slender, arising at short intervals from a creeping filiform stolon, unbranched, zig-zag, and divided by constrictions immediately above each calycle into a series of rather lengthened internodes each of which supports only one hydrotheca. The hydrothecæ are biserial and alternate, they are broadly tubular, but wider at the base

where alone they are adnate, being narrower at the orifice, which is square, and has the margin produced into four nearly equidistant teeth, they are all more or less deeply annulated or spirally ribbed.

Gonosome.—Unknown.

Habitat.—Off Cape Comorin in 40 fathoms, and off the Arrakan Coast in from 10 to 15 fathoms.

This hydroid bears a very close resemblance to *S. tenella* of Alders, but differs from it in the stem not being twisted at the joints and in the spiral ribbing of the hydrothecæ.

Thimaria compressa (nov. spec.)
(Plate XII.)

Trophosome.—Stems sparingly clustered, about an inch and a half in height, unfascicled, erect, more or less decidedly zig-zag, rooted by a creeping tubular stolon, and giving origin to a limited number of pinnæ. The pinnæ are alternate, few in number, and arise at regular intervals from the main stem, of which they are for a short part of the commencement of their course mere diverticula, being identical with it in structure, destitute of hydrothecæ, and with two annular constrictions marking the origin of each. The terminal nine-tenths of its length is made up of an aggregation of closely packed subalternate hydrothecæ, which are continued to its termination. Very often, however, the pinna is composed of a linear series of two or sometimes of three of the simple forms above described. The lower half of the hydrotheca is broadly tubular and adnate, the upper half is narrower, free, and projecting horizontally outwards, the aperture is oblique with the lower margin prolonged into a sharp tooth.

Gonosome.—Unknown.

Habitat.—Extremely abundant on the rocks between high and low water at Diamond Island, as well as amongst the laterite rocks on the Konkan Coast. I have also dredged it in 40 fathoms of water off Cape Comorin.

Antennella allmanni (nov. spec.)
(Plate XII.)

Trophosome.—Stems sparingly clustered, very slender, gently curved from base to apex, rooted by a slender filiform stolon, and attaining a height of about half an inch; they are divided by long, oblique partitions into a series of internodes, each of which carries an hydrotheca and four nematophores. The hydrothecæ are campanulate with large patulous orifices and perfectly even slightly everted margins. The nematophores are four in number on each segment of the stem, two lateral, one inferior and one superior. The lateral nematophores are quite free, long, narrow, and trumpet-shaped with a circular aperture and everted margin, from which they gradually taper down to extremely fine points, which are at-

tached, one on each side, to lateral processes of the stem, by a joint which allows the slightest motion of the water to communicate free vibratory oscillations to the nematophore. The inferior nematophore is free, tubular, much shorter than the lateral, and arising from a tumescent prominence on the stem, slightly below the base of the calycle, is directed upwards towards its anterior aspect. The superior nematophore is somewhat smaller, but in form and direction corresponds precisely with the inferior, it arises on a level with the upper margin of the calycle from the stem, which is here quite even and presents no enlargement similar to that which marks the origin of the lower nematophore.

Gonosome.—Unknown.

Habitat.—Off Cape Comorin in 50 fathoms, and off the coast of Cheduba Island in 8 to 10 fathoms.

Endendrium ramosum (nov. spec.)

(Plate XII.)

Trophosome.—Tree-like, stem much and irregularly branched, attaining a height of 3½ or 4 inches, fascicular and rooted by an entangled mass of short fibrous filaments, the branchlets are more or less dichotomously arranged and are all annulated at their origins.

Gonosome.—Gonophores consisting of clusters of spherical bodies, filled with a granular substance. They appear not to be borne on true blastostyles, but on the bodies of atrophied hydranths from which the tentacles have disappeared.

Habitat.—In 40 fathoms off Cape Comorin, and very sparingly, in from 10 to 70 fathoms, along the coast of Arrakan.

XI.—*Notes on the Formation of the Country passed through by the 2nd Column Tal Chotiali Field Force during its march from Kala Abdullah Khán in the Khójak Pass to Lugárí Bárkhán. Spring of* 1879.—*By* Lieut. R. C. Temple, 1*st Ghoorkas.*

(With Map—Plate XIII.)

General Features—There are one or two features general to the country passed through upon which it would be as well to remark before proceeding to note in detail the formations met with during the various marches.

The Glacis.—The most remarkable feature to be observed all over Southern Afghanistan is the peculiar gradual slope, or *glacis*, leading up

to the foot of the hills which encompass the numerous valleys into which the country is split up. The hills, which are usually bare of trees, of course vary greatly in height and form, but uniformly at foot is this glacis or slope between them and the valley level. It varies, of course, under various circumstances as to length and height, but its presence is invariable. To the west of the Khójak Pass, where the so-called Khója Amrán Range rises some 3000 feet above the valley—the Kadanei—it is about 15 miles long and 1000 feet in height, *i. e.*, the apparent foot of the Range is about 1000 feet higher than the real level of the valley. In the narrower valleys, such as the Gwál near Quetta, which is only 3 to 4 miles broad, the glacis on either side reaches nearly to the middle of the valley. It is generally very stony and covered with detritus from the hills. The streams over it, which are very numerous as a rule, have wide stony beds over which the water rushes with ever so much force, but to no great depth, after every heavy fall of rain. The torrents very quickly dry up, and very few of the streams have even a little water trickling in places from springs in the bed. The larger streams rush down several channels, the higher spots between which seem also to be liable to sudden and violent floods whenever a more than usually heavy fall of rain occurs in the hills above. These facts seem to lead to the hypothesis that the slopes have been formed by excessive denudation going on in the hills in consequence of their bare and treeless condition. But there seems to be another cause. Many of the hills, especially about the Pishin valley, appear to be formed of a slaty shale which is much disintegrated and split up at the surface towards the hill tops. It can be broken, or rather chipped, off easily by the hand, or even by the mere weight of the foot passing over it. The cold at the summits of these bare and exposed hills is intense; the heights being, say 7500 to 8000 feet, and it is possible that denudation is helped by the action of frost which separates the shale chips to be washed down by the next shower; and from the appearance of the hill sides it is probable that large quantities of these chips are in places brought down by every shower.

Metals.—Many parts of the country appeared to me to contain copper and iron in large quantities in the soil, but the specimens sent herewith will probably do something towards proving their presence and in what quantities they occur. There is a small isolated hill in the Dof valley, at the entrance of the Surai Pass, which appeared to me to affect the action of my prismatic compass. I have heard it asserted that gold is to be found in the quartz about the Pishin valley and the Khója Amrán Range, but I cannot say I saw any myself or any quartz likely to be auriferous.

Salts.—The soil in many places is white with nitre or salts of sorts: and this occurs in all parts of the country traversed. The water in many

places, both well and river, evidently holds salts in solution; in some places, as in Sagar and the Trikh Kuram Pass, it is undrinkable from its saltness.

Overgrowths.—One of the most distinctive features of Southern Afghanistan is the want of trees, but this appears to me to be due more to the inhabitants than to nature. In the higher regions, *i. e.*, above 8000 feet, the hills and uplands are fairly wooded with junipers and conifers of sorts, and wherever from various reasons the country is uninhabited, as in the Surai Pass, the Hanumbár Pass and all the land between the Trikh Kuram Pass and the Han Pass the country is fairly wooded with olives, bér and bábul trees with tamarisks and a dwarf palm in the lower and damper grounds. Indeed about the Hanumbár Pass there is a forest of bér and bábul trees. There is, however, another general feature to be observed everywhere after the Bolán and Han Passes are once crossed, the presence of southernwood and camel-thorn, which is universal. Grasses also of sorts flourish in most places, so that it may be presumed that the soil is the reverse of being unproductive were any efficient system of irrigation to be introduced. And it did not appear that water is really wanting in the country if trouble and skill were used in finding it.

Fossil remains.—After Khwára in the Shór valley testacean fossils abound, and the hills about the Hanokai and Han Passes may be described as being one mass of fossils, some in a wonderfully complete state of preservation, as the accompanying collection will show. They appear to be of the post-tertiary period. The same may be said of the whole country between the Han Pass and the plains *viá* the Cháchar Pass. I only saw one fossil of an animal which was picked up near Ningánd in the Ghazgai valley. (No. 203.)

Notes en Route.

North Pishin Valley.—Hills apparently of volcanic origin, basalt and shale; quartz is found in layers between the strata which are irregular, faulty, and much folded with dips at great angles. The hills are bare and greatly scoured by water. The Pishin is an open valley about 25 miles long and 20 miles broad.

Kala Abdullah Khán.—The hills about this point are bare and somewhat bleak.

North Pishin to Badwán.—The country along the road is intersected by a series of water channels and torrent-beds carrying down enormous quantities of detritus from the hills to the north of the valley, the land between them being much water-worn, apparently scoured after every shower and liable to sudden and violent floods.

To A'lízai.—Country torrent-scoured and covered with detritus and in places much broken by the wash of the water: soil, light and sandy.

To Khúshdil Khán.—Country near the hills stony, water-washed and covered with detritus: it is intersected by several torrent beds: soil, light and sandy. About the low lands the country much broken and intersected by deep nullahs: soil, clay. The country is everywhere bare of trees.

To Sharan Káréz, N. E. Pishin.—On the glacis country stony and covered with detritus, intersected by torrent beds. Hills apparently composed of slaty shale and slate with layers of schist cropping up. Country about Sharan Káréz much broken.

Surai Pass.—The country is wild and broken, consisting of a series of conical hills of slaty shale and slate, much disintegrated at the surface, probably from the action of ice and frost.

Dof Valley.—This valley is about 15 miles long by 8 broad. The glacis and water-scoured appearance of the country is similar to that observed in the Pishin valley. Soil, light and friable and not so good as in the Pishin valley.

Gwál Valley.—Valley about 20 miles long by about 3 to 4 broad. Country much the same as before: soil, not deep, say 2 to 2½ feet deep over conglomerate, it is very light and friable.

Pinikai Hills.—The hills are apparently of conglomerate and much water-worn. They have the appearance of being formed of the detritus of a lofty range of mountains like the lower hills in the Himalayan Ranges. The soil seems to be strongly impregnated with lime.

Gurkhai Defile.—The defile is of variable width, having high precipitous rocks of sandstone and grey limestone in the narrower places. It is broken up by low conical hills of soft red and grey clay in the wider portions.

Sagar.—The country is excessively wild and broken. Sagar is a kind of valley between high hills, but it is full of small conical hills of clay and in places of soft disintegrated shaly slate. The soil varies greatly in colour; white, grey, yellow and a bright red in the clay and bluish in the slate hills, trees are scarce.

Mosái Pass, gorge of the R. Zadún.—Hills at first of soft shaly clay and ironstone, but in the gorge of the river Zadún they are very similar to those in Sagar, and of red, yellow and grey clays. Afterwards the hills become undulating and apparently are of sandstone.

Gorge of the R. Rod.—High mountainous limestone hills with fairly horizontal strata. The soil about I'saf Kach is sandy.

Ush Pass; Ispira Rágha.—The hills as far as Ispira Rágha seem to be composed of sandstones, clays of various colours, slate and shale,

and lime crystals of sorts abound. The country is fairly wooded with junipers, conifers and bér trees: about the Ush pass it is fairly open; about Ispira Rágha wild and hilly.

Topobargh Pass; Momand.—Country same as about Ispira Rágha. Mómand is an open upland hilly plateau.

Nangalúna Pass and Plateau.—Country about the Pass is hilly, broken and rocky (gneiss). After the Pass the plateau is reached. It is of considerable width, but it is intersected by curious low flat-topped hills running north to south. It is wooded, as before, in the upper heights, but is bare of trees below 8000 feet. The hills appear to be composed of clays and sandstones of sorts with schist and gneiss cropping up in places.

Khwára.—After Khwára limestones begin to predominate and fossils, especially testacean, to abound.

Chimján.—The country is waterscoured, stony and treeless.

Mt. Syájgai.—Mt. Syájgai is a curious isolated mountain in the middle of the Shór valley. It rises about 1000 feet above the valley and almost perpendicularly for the last 300 feet. It is flat-topped, measuring at top about $2\frac{1}{2}$ miles in length by about $\frac{1}{2}$ mile in breadth. It is of limestone and full of fossils even at the summit. Fossils abound also about Chimján.

R. Zaghlun to Pálkai Pass.—The country is here remarkable for five almost parallel lines of hills about one mile to $1\frac{1}{2}$ miles apart enclosing hilly valleys. After these the country to the north is mountainous as far as the Zhób valley, 12 miles. The hills appear to be of limestone with trap in the gorges. The strata are very much broken and faulty.

Shór Valley.—Country much water-worn and very stony. The valley is about 20 miles long and about 5 to 15 miles broad.

Mzarai Valley.—The country much as before, but cut into by deep nullah beds.

Baiánai Pass.—Hills of soft white limestone. Country wild and rugged, much cut into by nullahs which are full of limestone chips from the hills, white, greenish and reddish.

Ghazgai Valley.—Valley 15 miles long by about 5 broad. Country as before, but more grass and overgrowths. Soil, richer than heretofore. Hills of limestone with very folded strata.

Borai Valley.—This valley is, say, 40 miles long and from 8 to 15 miles broad. The soil is good and fertile; there is no water-scour except about the streams; putt and kunker are found in the lower lands. Hills of limestone with very broken strata.

Hanumbár Pass.—Country *en route* various; putt and rough stony water-worn places, especially about the rivers, of which 4 or 5 meet in the Pass, which appears to be the only outlet southwards for some distance

along the hills south of the Borai valley. In the Pass the country is wild, hilly and wooded. There is forest land to the south of the Pass and much grass. The hills are of limestone with much folded strata in which fossils abound.

Sarghar Valley.—At first forest land is met with and then an open putt plain some 10 miles across : the soil is fertile.

Trikh Kuram Pass.—Country wild, hilly and much broken. The hills are apparently of limestone in which fossils and crystal abound. Gypsum crystals show themselves and often they are abundant.

Dérama Valley; Kutsa Valley.—These are grassy upland plains much intersected by stony beds of torrents.

Jarai Tang Pass.—This is a very stony, but short, passage through a hard limestone hill.

Tsamaulang Valley.—Country, putt crossed by deep river channels, but stony in places. The valley is about, say, 40 miles long by about 7 broad.

Hanokái Pass.—The Pass is at first very narrow with precipitous sides through a limestone hill; it then opens into a broader valley which is, say, half a mile wide, but full of low conical hills which in places appear to be formed of disintegrated white limestone, the rock being very friable. Sea-shells not fossilized, especially oysters, were found all through this Pass. Gypsum is abundant, so also are fossils. The hills are of soft limestone, the strata being horizontal.

Jurnái Pass and Valley.—Hills of soft limestone. Country wild and lumpy, and it might be described as being one mass of testacean fossils in a good state of preservation. The same remark applies to the country from this point to the Indian plains, some 150 miles as the road goes. A series of parallel valleys seems to run from the Derama hills to the Jándhrán hills, all more or less resembling each other.

Bála Dháka.—This is an open valley with low rolling hills at the northern end. The general formation of the country seems to be of limestone of more or less hardness.

Hán Pass.—In the Bala Dhákí Pass the rocks are hard limestone and precipitous with broken strata: in the Han Pass the strata are horizontal and the rocks softer, and there is much loose earth and clay full of nummulites and testacean fossils of all descriptions. In fact, the whole, hills and country, is a mass of fossil remains. In the Han Pass the country is wild and lumpy.

Chor Tarap Ravine.—The Chór Tarap ravine is curious. It is a sharply cut, narrow defile in a line of hills from 10 to 30 yards wide and, say, 200 yards long. The sides are full of fossils.

Bárkhán (properly Bárkhóm).—When once the Han Pass is crossed

there is a remarkable change in the country, like the inhabitants, it becomes Belóch in form. The glacis, so remarkable in all parts of South Afghanistan, now disappears and the hills stand out sharp in a flat desert-like valley. The valleys are of putt in which the vegetation is in tufts and has the same character as that observable anywhere in the Belóch plains. The country seems to be of limestone formation and fossils abound everywhere, even in the putt. In the hills the strata as usual are horizontal in some places and much folded and faulty in others.

Cháchar Pass.—The above description applies to the whole country between Bárkhán and the plains. It consists of a series of valleys and mountain ranges of more or less breadth, all of limestones, soft and hard and of all colours. Fossils are abundant everywhere, on the hill sides, in the soil and in the river-beds.

Itinerary.

No. of Stage.	Name.	Distance. miles.	Height above sea level.
	From Kala Abdullah Khán to		
1.	Badwán,	6½	5600
2.	Alízai,	19	5500
3.	Khúshdil Khán,	30	5600
4.	Sharan Káréz,	36½	6300
5.	Balozai Káréz,	45	6600
	1st Excursion. Gwál, 10. m. 6100.		
	2nd " Ámadún 15. m. 6300.		
6.	Ísaf Kach,	54¼	9400
7.	Ispira Rágha,	70¼	7800
8.	Khwára,	83¾	7900
9.	Chimján,	90¼	7400
	3rd Excursion. Pálkai Pass 10 m. 8500.		
10.	Baiánai,	112¼	6500
11.	Ningánd,	121¾	5700
12.	Wariágai,	134¼	4900
13.	Sharan,	150¼	4300
14.	Hanumbár Pass,	162¼	3800
15.	Trikh Kuram Pass,	180¾	4100
16.	Tsamaulang,	196¾	4000
17.	Bála Dháka,	207¾	4100
18.	Mitthí Khúín,	223¾	3800
19.	Lugárí Bárkhán,	236¼	3100

XII.—*Notes on a collection of Reptiles and Frogs from the neighbourhood of Ellore and Dumagudem.*—*By* W. T. Blanford, F. R. S., &c.

(Received August 3rd; read August 6th, 1879.)

In the year 1871 I was engaged for some months in the Godávari valley near the first barrier, and in the country between Dumagudem and Ellore. Dumagudem is the station where the Engineers, engaged on the works connected with the first barrier, used to live.

The country is herpetologically but poorly known, and the following list of the species noticed may therefore be an addition to geographical distribution. Nearly the whole tract is covered with thin forest, and the soil is very sandy.

A portion of the collection made has been lost or mislaid, and cannot now be found. The list appended is doubtless very imperfect; several common forms, such as *Naja tripudians*, *Ptyas mucosus*, *Dendrophis picta*, *Lycodon aulicus*, &c., not being included, although they undoubtedly occur. The collection was made in the driest months of the year, from February to May, and the list of lizards is consequently, in all probability, much more nearly complete than that of snakes or *Batrachia.*

REPTILIA.

Chelonia.

1. Testudo elegans.

2. Pangshura tecta var. intermedia, J. A. S. B., XXXIX, 1870, Pt. 2, p. 339. The Godávari form is similar to that found in the Mahánadi. The natives, who eat several kinds of freshwater tortoise, will not feed on this species, as they say it makes them ill.

3. Batagur ellioti? Godávari river.

The only specimen obtained was about 6 inches long. The head was dusky brown with 4 broad blackish indistinct longitudinal bands on the nape and back of the neck. Legs dusky grey. Claws pale yellowish.

4. Trionyx sp.? Godávari. My specimens are not now available for comparison, but Dr. Anderson tells me he believes the species to be *T. leithi.* It is probable that more than one species are found in the Godávari. The only specimens of *Trionyx* obtained by me were young individuals. They were olive in colour with 4 ocelli on the back, white beneath, nape ferruginous with violet streaks. Tubercles on the carapace rather large.

Some individuals of *Trionyx* or one of the allied genera grow to an enormous size. I was assured that a freshwater turtle 6 feet long was caught in the Godávari by the Captain of one of the river steamers. I cannot answer for

the accuracy of the measurement; a foot or two may have been thrown in. But I once saw, on the Indus, a very large individual belonging to some species of the *Trionycidæ* basking on a sandbank. I was on a steamboat, and the turtle took refuge in the water before the vessel was sufficiently near to enable his dimensions to be accurately estimated, but my impression was, that the carapace could not have been much less than 5 feet long, and it might well have been more.

5. EMYDA VITTATA. One specimen was obtained on the 13th March in forest, far from water. This individual probably came from a tank that had dried up. Other specimens were procured from the Godávari river. None exceeded about 5 inches in length, and in all, the odd osseous plate in the middle of the sternum was concealed, if present. I did not, however, macerate or dissect a specimen, and I have none remaining now to examine.

CROCODILIA.

6. CROCODILUS sp. I do not know what is the species common in the Godávari, as I never had an opportunity of identifying a specimen. It is by no means improbable that more than one species occur in the river.

The Gharial is not found in the Godávari, nor, so far as I know, in any of the rivers of the Peninsula further South; nor is it found in the Nerbudda or Tapti. It is common, however, in the Mahánadi of Raipur, Sambalpur and Orissa.

LACERTILIA.

7. VARANUS LUNATUS. I twice obtained specimens of this monitor, or at least of a species which I believe to be *V. lunatus*,* in the country north of Ellore. The largest, a male, measured 23·5 inches, of which the tail from the anus was 14·5. There were about 110 cross rows of scales from the gular fold to the loin. The following is a description of the fresh colouration. Above brownish olive, with irregular cross rows of minute whitish spots on the back, passing into ill-marked cross bands behind. Tail dark near tip, the anterior portion somewhat irregularly spotted with dusky. Limbs finely dotted with yellow, the spots on the hind limbs surrounded with dusky. Lower parts irregularly mottled with yellow and pinkish brown. There is a tendency to ocellation on the side behind the shoulder. The dark colour of the upper parts passes gradually into the paler tints of the lower. Iris yellow, pupil circular. The reversed V-shaped dark cross bands, on the neck, supposed to be characteristic of *V. lunatus*, were not observed. This species is purely terrestrial, so far as my observations go, and lives in holes at the roots of trees, and in similar places far from water. It is diurnal in its habits.

* See following paper on Ajmere Reptiles.

8. CABRITA LESCHENAULTII, (J. A. S. B., XXXIX, 1870, Pt. 2, p. 345). Not rare in the dry forests on the Godávari. I find I was in error after all in supposing that *C. leschenaultii* and *C. brunnea*, are distinct; (see Günther P. Z. S., 1875, p. 225, and some notes by myself, P. Z. S., 1876, p. 635).

Up to April the only individuals I observed were adults, but in that month I found great numbers of young. These are coloured much like the adult, but the tints are brighter, and the distal portion of the tail is light orange, the head shields are quite smooth, not corrugated as in older individuals, and there were two post-nasals in all the specimens I examined under 3 inches in length. Afterwards, in May, I obtained many rather more grown, from $3\frac{1}{2}$ to $4\frac{1}{2}$ inches long, with but one post-nasal. As I was moving about, and procured specimens from different localities, this distinction may have been local and not due to age, but it is evident that the character of having one or two post-nasals is of no specific importance. The same variation is found in the nearly allied genus *Ophiops*.

The rugosity of the head plates appears to be a generic character of *Cabrita*.

9. CABRITA JERDONI, (Beddome, Mad. Monthly Jour. Med. Sci., January 1870, p. 34; Günther, P. Z. S., 1875, p. 225; W. Blanford, J. A. S. B., 1870, Pt. 2, p. 348; P. Z. S., 1876, p. 635). Dr. Günther supposed that this was the same as *Ophiops jerdoni*, but, on my sending him a specimen of the *Cabrita*, he saw, of course, that the two were quite distinct, and that he had been misled by an erroneous label.

C. jerdoni is common in the forests on the Godávari, more so I think than *C. leschenaultii*. I did not meet with *Ophiops microlepis*; it appears to be a northern and western form. (P. A. S. B., 1872, pp. 72, 74.)

10. EUPREPES (*Tiliqua*) CARINATUS.

11. EUPREPES (*Tiliqua*) MACULARIUS. (J. A. S. B., 1870, Pt. 2, p. 358; Stoliczka, J. A. S. B., 1872, Pt. 2, p. 117; P. A. S. B., 1872, p. 75.) As indicated by myself and much more clearly shewn by Dr. Stoliczka, there are two well marked varieties of this scinque, so well marked, indeed, that it is almost a question whether they should not be distinguished. The one is more slender, and more uniformly coloured above and on the sides, the other is stouter, with the posterior part of the dorsal surface distinctly spotted with black and the sides punctulated with white. In the former there are, as a rule, seven keels on each of the dorsal scales, on the latter five. The former is true *E. macularius* of Blyth, the latter, for the sake of distinction, may be called *E. macularius* var. *subunicolor* or *E. subunicolor*,* ac-

* E. macularius *var.* sub-unicolor *a typo differt dorso, lateribusque parum vel haud maculatis, formâ graciliore, scutis dorsalibus plerumque quinque-carinatis.*

cording as the distinction is considered specific or not. For the present I am by no means satisfied that the two forms do not pass into each other too gradually to render it desirable to accord them specific rank, but as one, the smaller more uniformly coloured variety, is typical of the drier climate of the Central Provinces, whilst the more highly coloured form is found in Lower Bengal, and to the eastward, some distinction in name is useful.

In the comparatively dry forests on the Godávari around Dumagudem I met with the var. *subunicolor*, whilst the typical form was obtained nearer to the sea coast in the vicinity of Rájámahendri.

It is easy to understand how naturalists who have seen but few specimens may mistake these scinques for the young of the common and very variable *E. carinatus.* A comparison of the two, however, will shew the difference. The young of *E. carinatus* has but three keels on the dorsal scales, the back is unspotted and there is a well marked pale whitish line from the superciliary region down each side of the back.

The breeding season and colouration are different in *E. carinatus* and *E. macularius.* In the former the breeding season on the Godávari appears to be March. The colouration is probably confined to the male, but I can find no notes on the sexes of the specimens examined. The colour has already been described by me (J. A. S. B., 1870, Pt. 2, p. 357). When most fully developed the lower parts are rich gamboge yellow with a broad scarlet band on each side of the abdomen from shoulder to thigh.

E. macularius breeds in May, and towards the end of that month I captured richly coloured specimens between Dumagudem and Rájámahendri. In these the deepest seasonal tints were on the sides of the neck and breast. A scarlet band covered the lower labials and extended to the upper labials and rostral; it became very broad beneath the ears, and more broken and patchy behind, but it was traceable as far as the thigh. In less fully coloured individuals the red colouration did not extend behind the shoulder. All the lower parts had a slight reddish tinge, but no trace of the bright yellow of *E. carinatus.*

12. Riopa albopunctata.

13. R. hardwickei. Both these species were obtained on the Godávari, but neither appeared to be very abundant.

14. Hemidactylus subtriedrus. See Stoliczka, J. A. S. B., 1872, Pt. 2, p. 93. Near Ellore.

15. H. maculatus.

16. H. leschenaultii. P. A. S. B., 1871, p. 173; Stoliczka, J. A. S. B., 1872, Pt. 2, p. 97.

17. H. GIGANTEUS, Stoliczka, J. A. S. B., 1872, Pt. 2, p. 99; Günther, P. Z. S., 1875, p. 226; W. Blanford, P. Z. S., 1876, p. 636.

Of these species of *Hemidactylus* I made over my specimens to Dr. Stoliczka for description. Dr. Günther considers *H. giganteus* a variety of *H. coctæi,* but I have shewn that, so far as Indian specimens of the latter are concerned, there are well marked distinctions.

18. SITANA PONDICERIANA. The smaller race only. I saw none with the brilliant colours of the gular appendage developed up to the end of May; the colouration being, as has already been noticed, (J. A. S. B., 1870, p. 366,) purely seasonal, at all events in the smaller race.

19. CALOTES VERSICOLOR.

20. CHARASIA BLANFORDIANA, Stoliczka, J. A. S. B., 1872, p. 110. Without a much better series for comparison than I possess, I am not prepared to say whether this northern form can be distinguished from the southern race with rather smaller scales found in Mysore and further south. Specimens from the neighbourhood of the Godávari have about 100 scales round the middle of the body. Common on rocks.

21. CHAMÆLEO CEYLONICUS. Common.

OPHIDIA.

22. TYPHLOPS BRAMINUS. On two occasions I found great numbers of this blind snake in decayed wood; in one case there must have been at least a hundred in one fallen tree. None exceeded $5\frac{1}{2}$ inches in length. No other species of *Typhlops* was observed.

23. ONYCHOCEPHALUS ACUTUS.

24. OLIGODON SUBGRISEUS? The only important distinction from the description of this species shewn by the single specimen collected consists in the presence of two præoculars instead of one. The following is a description of the snake.

Scales of body smooth, in 15 rows. Ventrals 185, anal divided, subcaudals in 40 pairs. Length $17\frac{3}{4}$ inches, of which the tail was $2\frac{1}{4}$.

Seven upper labials, 3rd and 4th entering the orbit; 2 præ- and 2 post-oculars; a small square loreal.

Colouration, when fresh, light yellowish brown above, with a narrow pale line along the middle of the back from head to tail, and two broader pale lines, each as wide as two scales, down each side from head to anus; below these is a narrow dark line, then pale again. There are rudimentary cross-markings on the back, due to rows of scales with black margins alternating with other rows that are white-edged. On the head the markings are faint, a dark cross-band from eye to eye, edged behind with whitish,

and a double rather broad V-shaped mark, with the angle directed forward, on the vertical and occipitals.

25. Simotes russelli. One young specimen only.

26. Ablabes humberti, var. (P. A. S. B., 1871, p. 174). Several specimens were obtained, in the neighbourhood of Ellore, of a small snake, only differing from South Indian specimens of *A. humberti*, in the number of ventral shields. To this variation I called attention in the short paper above indicated. The following is a description of the fresh colouration in the snake from Ellore.

Back pale coppery, sides lilac grey, lower parts very pale apple green; a series of small black dots along the middle of the back, at rather irregular intervals, from 2 to 5 scales apart, and two other lateral rows, one on each side of the ventral scales, consisting of a black dot on the side of each scale. An imperfect very narrow black streak runs down each side of the back. Head above mostly black, with a narrow yellow collar across the neck 7 scales behind the occipitals; this collar becomes broader at the sides. There is a patch of duskier yellow behind each occipital, the two patches separated by a central black line; from each patch a white band leads down to the upper labials. A white band runs along the upper labials and rostral, extending all round the upper jaw, and another runs from the rostral to each superciliary shield. Loreal region black. Each of the lower labials and chin shields with a white patch, bordered by black, anterior ventral shields with partial dusky margins. The specimen described was 10·5 inches long, the tail being 1·9. Ventrals 211, anal bifid, subcaudals in 56 pairs. In another specimen 13¼ inches long there were 209 ventrals. As was pointed out in the note already quoted, there were only 155 ventrals in a specimen from Malabar, 175 in one noticed in Günther's *Reptiles of British India*, p. 228, and no less than 240 in a Calcutta example. So great a variation in the number of ventral shields might indicate that several species are included, but there appeared no other constant difference in the specimens, and I may add that Dr. Stoliczka, who also examined them, agreed with me in classing all as varieties of one species.

27. Zamenis fasciolatus. A young specimen only, but one of the fiercest snakes I ever captured.

28. Tropidonotus stolatus.

29. Cerberus rhynchops, abundant in the salt water inlets and estuaries near Coconada, living in holes in the mud between tidemarks. A very gentle snake, not biting when handled.

30. Dipsas trigonata. The colouration varies in this snake. The specimen obtained had the head markings different from those described by Günther and on the back were irregular transverse whitish bands with

broad black edges; the median line being deficient, as in the specimens from Agra mentioned by Dr. Stoliczka, (J. A. S. B., 1870, p. 142).

31. Gongylophis conicus. Two specimens were obtained on the Godávari, they were very gentle and slow in their movements, like *Eryx.* One had swallowed a mouse. In a specimen 20 inches long, of which the tail measured 1½, there were 168 ventral scales and 18 subcaudals; the upper labials were 14, not 12. The colour was dark brown, with the blotches light brown in the middle and yellow on the margins.

32. Daboia russelli.

33. Echis carinata This was obtained on two or three occasions in forest,—rather thin forest it is true,—but it is remarkable to find a desert form like *Echis carinata*, so common in the barren plains and rocky hills of South-Western Asia, in a wooded country.

AMPHIBIA.

1. Rana tigrina.
2. R. lymnocharis.
3. R. cyanophlyctis.
4. Pyxicephalus breviceps.
5. Bufo melanostictus.
6. Polypedates maculatus.

7. Callula variegata, Stoliczka, P. A. S. B., 1872, p. 111. I obtained altogether five specimens of this species, from under logs of wood, near a village between Dumagudem and Rájámahendri. In size they varied from 1·1 to 1·35 in the length of the body, and the hind limb ranged from 1·23 in the smallest to 1·48 in the largest example. Four were under one log, one under another, and in each case the toads associated with a large scorpion, and tried to escape into his burrow when the log was lifted. They can hop but very feebly indeed. The body in life is extremely soft and slimy. The colour above, in the living animal, is dark brown, spotted with pale greenish or yellow, the spots are usually minute on the hinder part of the body and on the limbs, but form larger blotches on the back. The lower parts are dull flesh-colour.

XIII.—*Preliminary Notice of a new Genus* (Parectatosoma) *of* Phasmidæ *from Madagascar, with brief Descriptions of its two Species.—By* J. Wood-Mason.

The interesting and remarkable animals briefly noticed below formed part of a large collection of insects, chiefly Coleoptera, recently received in London from Madagascar, and I was fortunate, while at home on furlough, to secure specimens of them from Mr. E. W. Janson, the well-known Natural History Agent.

They are unquestionably nearly related to *Ectatosoma*, an Australian genus, the three known members of which are three of the most curious and striking forms comprised in the whole class Insecta. This relationship I have indicated in the name of the new genus which the differences presented by these insects compel me to propose for their reception.

Parectatosoma,* gen. nov.

Closely allied to the Australian genus *Ectatosoma*, but differing therefrom in the following characters:—the prothorax is relatively longer and more spiny; the male is devoid of ocelli, and, like the female, brachypterous; the abbreviated tegmina in both sexes are shorter than the abbreviated wings; and the upper crest of all the femora is produced into a sharp genual spine.

Of the species of the Australian genus, *Ectatosoma bufonium*, Westw., is the one which the Madagascar forms most nearly approach.

1. *Parectatosoma hystrix*, n. sp.

♂ ♀. Head armed with 12 spines (besides scattered spinules) arranged in four longitudinal rows and in pairs, of which one is large, compressed, and thorny, and constitutes the conspicuous cephalic horns; the pair of spines immediately in front of these is also compound, each being provided with a sharp spine-like cusp in front. The postantennary pair of spines is as well-developed as in *Ectatosoma*.

Sides and upper surface of prothorax strongly armed with thorns, some of which are double. The apices of the small tegmina barely reaching the bases of the wings, the true metanotum is consequently exposed and it is armed at the middle of its hinder margin with a pair of stout thorns. The tergum of the 1st somite and the terga of more or fewer (according to sex) of the remaining abdominal somites provided at their hinder extremities with two cross rows of spines. Posterior margin of tergum of last abdominal somite in the ♀ symmetrically divided into six spinous processes.

* From παρά, by the side of, and *Ectatosoma*, generic name.

Colour—deep black-brown, almost black, blotched with yellow, sparingly so on the undersurface and legs, but more profusely on the pronotum and on the terga of the abdominal somites, on which parts the colour assumes an orange tinge and extends to the points of the spines; the antennæ are ringed at the joints with the same colour; organs of flight, greenish yellow, with their bases and principal nervures black.

♂. Length of body 61 millims., of head 7, pronotum 5, mesonotum 14, metanotum 7, abdomen 25 + 7 = 32, tegmina 2·5, wings 8, fore femur 17, tibia 17·25, intermediate femur 13·5, tibia 15·5, posterior femur 17, tibia 21, antennæ 53.

♀. Length of body 86 millims., of head 10, pronotum 7, mesonotum 18, metanotum 10, abdomen 31·5, + 12·5 = 44, tegmina 4·5, wings 10·5, fore femur 19, tibia 20, intermediate femur 16, tibia 18, posterior femur 21, tibia 25, antennæ imperfect.

Hab.—3 ♂ and 3 ♀ from Fianaràntsoa; and 1 ♀ from Antanànarìvo, Madagascar, differing from the rest only in being much more variegated.

2. *Parectatosoma echinus*, n. sp.

♂ ♀. Slenderer, and less numerously and less strongly spined than the preceding. Head armed: ♀ with 10 spines besides spinules, the cephalic horns more foliaceous and more sharply spined, with only one pair of spines in front of them instead of two and that simple: ♂ with 8 only, one of the lateral pairs not being developed. Postantennary spines reduced to minute tubercles. Vestiges of wings and tegmina larger, those of the latter overlapping one another, and those of the former so as to conceal from view all but about one square millimetre of the unarmed metanotum. The tergum of the 1st abdominal somite with but one row of spines at its hinder end; that of the terminal somite ♀ divided at its posterior margin into four spinous processes.

Colour—body brown like rotten leaves, with the legs, antennæ, organs of flight (which have their principal nervures darker), and spines lighter.

♂. Length of body 64 millims., head 4·5, pronotum 4·5, mesonotum 14, metanotum 6, abdomen 27·25 + 8·5 = 35·75, tegmina 3·75, wings 7·3, fore femur 17, tibia 17, intermediate femur 12·5, tibia 13·5, posterior femur 17·5, tibia 19·5, antennæ 47.

♀. Length of body 80 millims., head 7, pronotum 6·5, mesonotum 16·5, metanotum 8, abdomen 31 + 12 = 43, tegmina 6, wings 11, fore femur 16·6, tibia 17, intermediate femur 12·5, tibia 13·6, posterior femur 18, tibia 21, antennæ 43·5.

The fore legs and all the tibiæ in the male of this species are nearly quite simple.

Hab.—1 ♂ and 2 ♀ from Fianaràntsoa.

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XIV.—*Notes on a collection of Reptiles made by* Major O. B. St. John, R. E., *at Ajmere in Rájputána.—By* W. T. Blanford, F. R. S., &c.

(Received and read August 6th, 1879.)

The following is a list of the reptiles obtained by Major St. John in the neighbourhood of Ajmere during about three years of residence. Most of the species were identified by the discoverer, but nearly all were sent to me for comparison. The list is small, and the fauna of the country is evidently poor, but still all local lists of this kind are of importance, especially if they approach completeness, as they afford very valuable aid towards a knowledge of distribution. In this list, for instance, I find that two species occur, *Cynophis helena* and *Python molurus*, belonging to two genera the existence of which in any part of Central or Northern India I previously thought extremely doubtful.*

The species marked with an asterisk are inserted from information sent to me by Major St. John, as I have not seen specimens. All others have been examined by myself.

*1. Testudo elegans.

*2. Crocodilus, sp. Major St. John writes: " Crocodiles (*C. palustris*, I suppose) are very numerous in the natural lake of Pushkar (or Pohkar) 6 miles from Ajmere. Some are also found in the artificial lake at Ajmere called the Anaságar; they are said not to breed there, but to

* Ann. Mag. Nat. Hist., October 1876, Ser. 4, Vol. XVIII, p. 292.

find their way over the ghat from the natural lake. I cannot hear of the existence of Crocodiles elsewhere in these parts, though they are found in a small tank in the Chittore hill fort, 100 miles to the south."

I identified the species found in Sind with *C. palustris,* and it is not improbable that the Ajmere crocodile may be the same. We are badly in want of a careful collection and comparison of Indian crocodiles; small specimens 2 or 3 feet long would be of service.

3. Varanus lunatus?

Three young specimens have been sent to me by Major St. John; they are respectively 19, 14 and $8\frac{1}{2}$ inches long. In the first I count 114 scales from the gular fold to the loin, in the second 98, in the third 104. Owing to the irregularity of the anterior scales, the number is not quite constant, but having counted the rows in each case two or three times, I only find a difference of one or two.

The colouration is also different in all three. The largest specimen is much darker than the others; yellowish brown in spirit, with small black spots more or less regularly arranged in transverse lines on the back, and narrow blackish cross lines on the neck. A few white spots, generally very small, are scattered quite irregularly over parts of the back, sides, limbs and tail. A black line from the back of the eye over the ear to the side of the nape.

The next specimen is paler yellowish brown, with cross rows of small white ocelli alternating with rows of dark spots throughout the back, and with somewhat irregular broad bands on the tail. The black line from behind the eye is less distinct.

In the smallest specimen, the ground colour is still paler, numerous dark bands cross the back and alternate with rows of minute white dots: on the tail the dark bands form rings, and are much broader than on the back; on the back of the neck the dark lines are V-shaped, the angle being directed backwards. The dark marks running back from the eyes meet on the nape, and form the first cross band. There are imperfect dark cross lines on the chin and throat.

The question arises to which species these monitors should be referred. *Varanus flavescens* and *V. nebulosus* are quite different, and it is clear that the Ajmere specimens, if they belong to a described form, must be either *V. dracæna* or *V. lunatus*. The distinctions between these species are variously described by different naturalists. Gray's original description of *Varanus lunatus*, in the *Catalogue of the Specimens of Lizards in the Collection of the British Museum* (1845) p. 10, runs thus:

"Nostrils large, nearly central, (*i. e.*, between the eye and muzzle,) shields over orbit small, subequal; dark brown, with lunate bands, directed backwards on the neck

and forwards on the body, and with cross bands on the tail; belly and under side of tail whitish."

While *V. heraldicus*, as Gray called *V. dracæna*, was thus described:

"Black with cross rows of pale-eyed spots, beneath pale, black-banded; shields over the orbits small, subequal."

The distinction, it will be seen, depends solely on colouration, and I may add that the colour assigned to *V. dracæna* is not that of a typical example by any means. In Günther's "*Reptiles of British India*," the differences are far better explained. *V. dracæna* is said to have the ventral scales in 90 transverse series between the gular fold and the loin, and the neck without angular dark cross bands. In *V. lunatus* the ventral scales are said to be in 105 transverse series, and the neck to be marked with dark angular cross bands, their points being directed backwards. The following is the description of the colouring of *V. dracæna*:

"Brownish olive, uniform or generally with more or less numerous black dots, each of which occupies a scale; these dots are sometimes arranged in irregular transverse series and are most numerous on the throat: young specimens shew numerous small white ocelli edged darker, whilst the lower parts are marked with irregular dark transverse bands."

It is mentioned that a young specimen from the Anamullay mountains (probably from the base, not the top of the hills) shews narrow black bands across the neck, "but they are much narrower than in *V. lunatus* and rather irregular." The colouration of *V. lunatus* is said to be—

"Neck, trunk, and tail marked with cross bands, which are as broad as the interspaces of the ground colour; these bands are angular on the trunk and neck, with the angle directed backward on the neck and forwards on the trunk—four on the neck, eleven on the trunk. Sides and legs dotted with white."

The single specimen in the British Museum, from which Gray's and Günther's description was taken, is stuffed and 25 inches in length, so that it is not in all probability full grown. It is said to have come from India, but no further information is available as to the locality. I examined this skin some years ago, when comparing the specimen from Baluchistan described in *Eastern Persia*, Vol. II, p. 360, but I could detect no character to be added to those noticed by Günther.

The matter remained thus till ten years ago. Then Carlleyle stated that both *V. dracæna* and *V. lunatus* occurred commonly near Agra, and that neither of them were "water-lizards." (J. A. S. B., 1869, Pt. 2, p. 195.) Next Jerdon (P. A. S. B., March, 1870, p. 70,) stated that he found *V. lunatus* in the Museums at Delhi and Lahore. Anderson, (J. A. S. B., 1871, Pt. 2, p. 30,) recorded the receipt, by the Indian Museum, of *V. dracæna* from Calcutta, Agra, the Khási Hills and Assam, and of *V. lunatus* from Agra and Goalpara (Assam). Dr. Stoliczka identified

the species found in Kachh with *V. dracæna* (P. A. S. B., 1872, p. 73,) and I similarly referred a Baluchistan specimen to the same species.

Lastly Theobald, in his "*Descriptive Catalogue of the Reptiles of British India*," 1876, p. 38, does little more than copy Günther's characters, but gives the additional localities subsequently recorded. In his Synopsis, at the end of the volume, he distinguishes *V. dracæna* as having the body black dotted, and *V. lunatus* as having the same yellow dotted; a distinction, I may at once add, with which I am unable to coincide.

So far as I know, no other specimen having the peculiar colouration exhibited by the type of *V. lunatus* has been observed. The colouration, of the neck especially, is peculiar and is shewn in Günther's plate. All who have endeavoured to discriminate the species in India have, I think, depended on the number of rows of ventral scales, specimens with less than about 95 rows (or to speak more correctly about 70 to 75 rows on the abdomen, and 20 to 25 scales less regularly arranged on the breast) have been referred to *V. dracæna;* those with 100 or more to *V. lunatus.* Stoliczka, however, referred Kachh specimens with 90 to 100 rows to *V. dracæna*, and I myself, after comparing a specimen from Baluchistan having 107 rows with the series in the British Museum, came to the conclusion that it must be classed with the same species. At the same time I expressed a doubt whether *V. lunatus* was more than a variety of *V. dracæna.*

On the other hand there is considerable reason for believing that the common *Varanus dracæna* of Bengal and Assam is a water lizard, inhabiting marshy places and entering the water freely like *V. flavescens*. The monitors of the North-West Provinces of India, of parts of Southern and Western India are purely terrestrial, as has been noted by several observers. Many of these terrestrial lizards have been classed by various writers as *V. dracæna*, and the question arises whether two species have not been confounded under this name. A second question is, whether the terrestrial lizard is not *V. lunatus.*

In the hope of determining this point, I examined all the Indian Museum specimens, which Dr. Anderson kindly placed at my disposal. The result is far from decisive, but it does appear probable that two well marked forms exist, the one inhabiting Bengal and Assam, the other ranging through the greater portion of the Indian Peninsula. The number of ventral scales is not sufficiently characteristic to serve as a distinction, although the form from the North West Provinces and Western India has decidedly smaller scales, both above and below, than the Eastern race. Indeed I have sought in vain for any well-marked character to distinguish these two. So far as I can see, the adults are easily discriminated by

colouration, and by the form of the dorsal scales. Assuming that the western form is *lunatus*, the following appear to be the distinctions.

V. dracæna. Back more rounded, and head higher. Scales throughout larger, the dorsal scales surrounded by granules, the central boss very convex, much longer than broad. The fold above the shoulder and along the side often ill-marked, and in old specimens wanting.

Colouration dusky yellow to greenish olive thickly speckled with black. In the young the dark transverse bands are broad, nearly equal to the interspaces.

V. lunatus? Back nearly flat, and head lower than in *V. dracæna.* Scales throughout smaller, notably so on the labials, and as a rule on the supra-orbital regions. The dorsal scales in adults surrounded by a broad band of granules, the central boss nearly flat, but little longer than broad. The fold above the shoulder running back nearly to the thigh, and forward on the side of the neck, well marked in young specimens, and as a rule in adults.

Colouration brownish olive to yellowish brown. Adults almost uniformly coloured or thinly dotted with black on the upper parts. In the young the transverse bands are narrower than the interspaces (the very young are indistinguishable, however, from those of *V. dracæna).*

It is not certain that the latter species is the true *V. lunatus*, but as that form has smaller scales than the typical *V. dracæna*, the monitor above described may be referred to it. Even now I am far from convinced that the two are absolutely separable

Varanus lunatus (if this be correctly identified) is common near Ajmere.

4. Ophiops microlepis. (J. A. S. B., 1870, Pt. 2, p. 351; 1872, Pt. 2, p. 90; P. A. S. B., 1872, p. 74.) This seem rather a widely-spread form. The present is the fourth locality noticed, the others are Bilaspur in the Eastern Central Provinces, Karharbári in Western Bengal, and Kachh.

5. Euprepes guentheri.

E. monticola, Günther, *Reptiles of British India*, p. 80, Pl. X, fig. C.—Stoliczka, J. A. S. B., 1872, Pt. 2, p. 120.—Theobald, *Desc. Cat. Reptiles Brit. Ind.*, p. 52.

Few people can be more loth to change a name which has subsisted for a considerable time than I am, but I think that this is clearly one of the cases to which the British Association rule, § 11, applies. That rule runs thus:—"A name may be changed, when it implies a false proposition which is likely to propagate important errors." Now the name *monticola* does imply a false proposition, for it indicates that the species so called is a

mountain form; Dr. Günther's information led him to suppose that this scinque inhabited Sikkim at an elevation of 8000 feet. Whence his information was derived is not mentioned, but Dr. Stoliczka was probably correct in attributing it to the Messrs. v. Schlagintweit, whose inaccuracy in these matters is notorious. Since the species was described, Sikkim has been searched by numerous collectors, but not a single specimen of this *Euprepes* has been found. Dr. Stoliczka noticed the improbability of this form occurring in the highlands of Sikkim, where not a single reptile found in the plains of India is known to occur, but he suggests that the specimens may have been procured in the warm valleys. It appears, however, that this scinque is an inhabitant of the dry parts of India. Major St. John has sent it from Ajmere, Mr. Theobald records it from Kálka, at the base of the barren lower Himalayas of the Punjab, and I have met with it in Upper Sind.* Now the fauna of the dry plains of Upper India is widely different from that found in the moist Sikkim valleys, and the only reptiles common to the two are a few species of enormous range, such as *Calotes versicolor* or *Naja tripudians*. I believe, therefore, that *Euprepes monticola*, like *Eryx Johnii* and *Gongylophis conicus*, owes its supposed Sikkim locality solely to an incorrect label, and therefore the retention of the name *monticola* "tends to propagate an important error." Under these circumstances I propose to re-name the species after the original describer, Dr. Günther.

Two specimens of *E. guentheri* have been sent by Major St. John; they agree with Dr. Günther's original description in all essential particulars, and still better with Dr. Stoliczka's. There are 35 or 36 scales round the body, the dorsal scales have two keels, sometimes with a faint third keel between the two stronger ridges; lateral scales with three keels.

E. guentheri is, according to Major St. John, common near Ajmere. It lives under bushes on the hill sides and in sand.

6. Hemidactylus triedrus, (*? subtriedrus*). (Stoliczka, J. A. S. B., 1872, Pt. 2, p. 93.) The only specimen procured was caught on Táragarh, close to Ajmere. There are unfortunately no specimens for comparison from Southern India in the Museum at Calcutta, and I have no longer those procured near Ellore. In the individual from Ajmere, as in those from Ellore, none of the trihedral tubercles is quite as large as the ear opening. The specimen is, unfortunately, a female, and has no femoral pores. The following are the principal characters.

Back with closely set trihedral tubercles, those in the middle a little

* I have also received from Mr. Wynne a specimen of a scinque procured in Hazára, and probably belonging to this species, but not in sufficiently good preservation to be identified with certainty.

longer than broad and arranged in longitudinal lines, those on the sides broader than long, not very regularly placed. Head above granular, with numerous small round tubercles. Tail with cross-rows of trihedral tubercles above, and broad plates below. Eight upper labials, seven lower; the nostril is separated from the first labial, but is in contact with the rostral; the plates behind the rostral are small; one pair of large chin shields only; about 34 scales across the abdomen. Scales below head and throat and those beneath the feet very small.

The general form is similar to that of *H. triedrus*, as represented in Belanger's "*Voyage;*" the head large and depressed; body stout. The length of the specimen is rather more than 2½ inches from nose to anus, the tail, renewed in parts, is 2 inches long.

Colouration in spirit light brown above, with, on the body, 5 broad transverse yellow, black-edged bands, the margins of which are wavy; the first on the nape without a black edge in front, the hindmost between the hind legs; similar but narrower bands across the upper part of the tail. Sides of head blackish, darker behind the eye than in front, with a pale line from the nostril to the eye continued behind the eye, to the nape, and another line along the upper labials, produced by some whitish tubercles to above the ear.

7. Hemidactylus coctæi.

8. Calotes versicolor.

*9. Chamæleo ceylanicus.

10. Typhlops braminus.

11. Oligodon subgriseus.

12. Cynophis helena. A specimen 41 inches long, agreeing very well with the description in Günther's *Reptiles*, except that the labials are more divided than usual, and the ventral shields more numerous. There are 11 upper labials on each side, the 5th, 6th and 7th entering the orbit; the præocular is large, extending to the upper surface of the head. Loreal divided into two shields, both in contact with the præocular, the anterior square, the posterior smaller, subtrigonal. Anterior frontals as long as broad. Ventrals 254; anal single; subcaudals in 75 pairs, the extreme tip of the tail having been lost.

13. Ptyas mucosus.

14. Zamenis diadema. A large specimen, 61 inches in length, agrees in most characters with Dr. Anderson's description (P. Z. S., 1871, p. 174,) of the form found in the neighbourhood of Agra. There are only 27 rows of scales round the body, the dorsal series being very distinctly keeled, the angulation of the ventrals is faint, and the præocular is divided into two.

The post-frontals are united into one shield, and there are three supplementary shields behind the post-frontal, as in the Persian form, *(Eastern Persia*, II, p. 412,) and not four as is usual in Indian specimens. There are 11 upper labials on one side, and 12 on the other. Ventrals 239; anal undivided; subcaudals in 110 pairs.

The whole upper surface of the head is black, the colour extending in part to the labials, the remainder of the body is pale sandy in spirit, almost cream-coloured, pinkish anteriorly on the back, and dotted here and there with black spots, which are quite irregular both in size and distribution: (see Stoliczka, P. A. S. B., 1872, p. 82.) In life, as I learn from Major St. John, the lower parts were bright salmon pink.

15. TROPIDONOTUS QUINCUNCIATUS. A single young individual is sent, only 12 inches long. Uniformly coloured above olive-grey in spirits, white below; even the characteristic black marks from the eye to the labials are wanting, although the posterior band is indicated by a faint dusky line.

16. PSAMMOPHIS CONDANARUS. The single specimen sent appears to approach the Sind form in some respects, and especially in having the nostril between two shields (Stoliczka, P. A. S. B., 1872, p. 83). But I find in a Sind specimen that the nostril is much smaller, the orifice being diminished by a valvular prolongation of the upper portion of the postnasal. This form leads again to *P. leithi*, in which, as I have shewn, *(Eastern Persia*, II, p. 421,) there appear to be two post-nasals.

In the Ajmere specimen the principal marking consists of 4 longitudinal equidistant dark-brown, almost black bands, two on the back and one on each side, extending from head to tail; the two upper bands coalescing on the tail. The bands are equal in breadth to the interspaces. The specimen is young; it measures only 23 inches, the tail being imperfect.

17. DIPSAS TRIGONATA. A small specimen only $15\frac{1}{4}$ inches long, of which the tail is but $2\frac{1}{8}$. The colouration consists of rather irregular white, black-edged patches, having a tendency to form transverse lines on the back. Ventrals 215. The tail is slightly imperfect, but only a very small portion can be missing.

In young specimens of this snake, at all events, the tail does not always amount to a fourth of the length. I find notes of two specimens from the neighbourhood of Ellore, measuring respectively $15\frac{3}{4}$ and $23\frac{1}{2}$ inches, with tails 3 and $4\frac{3}{4}$ inches long, or rather less than one-fifth in each case. In the Ajmere specimen the tail is even shorter, about one-seventh.

This snake was captured amongst stones, and had swallowed a young *Calotes versicolor*.

18. Lycodon aulicus.

19. L. striatus. Two specimens sent, one 11 inches long, the other $9\frac{3}{4}$. Major St. John notices that these snakes had no yellow coloration, and suggests that the tint may be seasonal. His examples were procured early in April.

*20. Python molurus. This, as already remarked, is an unexpected addition to the fauna of Rájputána. The specimen obtained by Major St. John was 10 feet long, and was captured in bush jungle near the Pokur lake among low hills on the edge of the desert.

21. Eryx johnii.

*22. Nají tripudians.

23. Bungarus cæruleus.

24. Echis carinata.

XV.—*Notes on* Reptilia.—*By* W. T. Blanford, f. r. s., &c.

(Received and read 6th August, 1879.)

In the course of the last few years I have received small collections of reptiles from several friends in different parts of India and Burma, and I have collected some myself in Sind and its neighbourhood, and in Darjiling. Although, with the exception of one snake *(Homalopsidæ)* described below, none appear to be absolutely new, there are a few calling for remark on account of rarity, variation, or from the locality being previously unknown. I have thrown together these somewhat desultory notes in the following pages.

LACERTILIA.

Mesalina guttulata (*olim* pardalis).

Dr. Peters informs me that the species identified with *Lacerta pardalis* of Lichtenstein by Dumeril and Bibron *(Erp. Gen.* V, p. 312) and by Gray *(Cat. Liz. Brit. Mus.* 1845, p. 43) is not Lichtenstein's species, but that it is his *L. guttulata.* I believe the original types of Lichtenstein are in the Berlin Museum and have been examined by Dr. Peters.

The species abounds in the countries west of India ('*Eastern Persia,*' II, p. 377), and was described from Sind by Dr. Stoliczka, who supposed it to be a new species which he called *Eremias (Mesalina) Watsonana* (P. A. S. B., 1872, p. 86; see also J. A. S. B., 1876, Pt. 2, p. 26). I have since found it as far to the eastward as Jaisalmir.

SPHENOCEPHALUS TRIDACTYLUS.

When in the Indian desert between Sind and Rájpútána in 1876, I daily saw tracks in the sand, which I believe to have been made by this lizard; but although I heard of the animal under its name of 'Rig mahi' I never succeeded in finding specimens. I believe that it is nocturnal in its habits, as I always found the peculiar vermiform tracks in the sand, which are, I believe, produced by it, fresh in the early morning. It has been obtained from both Sind and Cutch (P. A. S. B., 1872, pp. 76, 88), but it is said to be rare. I suspect, on the contrary, that it is common, but that, from its habit of burrowing and from its not moving about during the day, it is very difficult to find.

ZYGNIDOPSIS BREVIPES.

I am indebted to my friend Major Mockler for two additional specimens of this rare lizard. The single type was procured near Karmán in Persia at an elevation of 5,500 feet; the two specimens now sent are from some part of Southern Persia or Baluchistán, probably from near the coast, but I do not know the exact locality. The head was slightly injured in the original specimen, and those now procured shew the muzzle to be more conical than it is represented in the plate in '*Eastern Persia*' (see Vol. II, p. 397, Pl. XXVII, fig. 4) and the rostral shield to be distinctly angulate in front. The tongue too is slightly cleft at the extreme end.

Another error in the figure, judging from the more perfect specimens now procured, is that the tail tapers rather more than it is represented as doing. In neither of the specimens sent is the tail perfect; in one it has been entirely lost and the new growth is only beginning, in the other the extremity has been renewed. In one specimen the hind foot is one-fourth, instead of one-fifth, the length from thigh to shoulder.

The anterior margin of the vertical and the posterior margin of the præfrontal are straight, and so is the posterior edge of the vertical, not convex as in the type. The superciliary shields are also slightly different from the figure, the third from behind being the largest and fitting into the emargination on each side of the vertical.

The coloration is paler and consists of narrow brownish longitudinal lines, the only conspicuous bands being one on each side from the nostril through the eye down the upper part of each side.

The specimens are smaller than the original type, one being 3, the other 3½ inches from nose to anus.

DRACO sp. (? D. MAJOR, var.)

A single specimen of *Draco* of large size, sent to me by Mr. Davison, closely resembles *D. major* (J. A. S. B., 1878, XLVII, Pt. 2, p. 125), but

the hind limb just reaches the axil, the tympanum is covered with one or two large scales instead of being quite naked, and the nostrils are not directed upwards. If the last character were certain, there could be no doubt about the specific distinction of the species, but one nostril has a distorted look, and there is an opening from one nostril to the other through the septum, so that it is possible to see through both nostrils. Now the specimen having been obtained by an ornithologist, I think it has been carried, when freshly killed, suspended to a stick with a pin thrust through the nostrils—the common plan employed for carrying birds by collectors—and I am not sure how far the nostrils have been distorted by the process. The other differences are less important; in forms like *D. maculatus* with the tympanum scaly, the area is covered with small scales; and in those with a naked tympanum, part of the space is often occupied by a large flat scale.

The membrane of the 'wings' is dark-coloured, rather darker towards the margin than inside, with small spots formed of larger white scales. These spots are not arranged in as distinct rows as in typical *D. major*. Otherwise the coloration is the same in both. The length is 12 inches, of which the tail measures 8.

This may be a new species and I therefore call attention to it. I am much inclined, however, to believe it is a variety of *D. major* with the nostrils distorted.

Stellio tuberculata.

As might have been anticipated, this proves to be, in part, a vegetable feeder, like allied species. Mr. Wynne noticed some lizards feeding on leaves at Murree, and sent me a skin of this species and some of the contents of the stomach, which proved to be a mixture of fragments, partly of insects, partly of vegetables.

Agama agilis.

Dr. Peters writes to me that this species is *Agama sanguinolenta* of Pallas, and must take Pallas's name. It is also, Dr. Peters says, *A. aralensis* of Lichtenstein; the true *A. agilis* of Ollivier being a form allied to *A. (Trapelus) ruderata*. I am unable to examine into this question at present as I have not now access to Ollivier's work.

I found the lizard hitherto called *A. agilis* by myself and others (see *Eastern Persia*, II, p. 314 and J. A. S. B., 1876, pt. 2, p. 22) abundant near Jaisulmir in the sandy desert to the east of the Indus. I once or twice saw this species on low bushes, precisely as I have observed *Trapelus ruderatus* in Persia.

ACANTHOSAURA ARMATA.

I am indebted to Mr. Davison for specimens of this lizard from the neighbourhood of Moulmain and from Tavoy. Both forms differ somewhat in coloration from the published description. The Moulmain specimens are large, being nearly 12 inches long, and all the upper portions are dusky, the tail with pale rings, lower parts pale, the colour extending up the sides of the head and neck, in the former to just below the eye and in front to the *canthus rostralis* and on the neck, so that there is only a belt of black about one-eighth of an inch broad on each side of the crest; no radiating lines from the orbit over the lip. In the Tavoy specimens, which are younger, the upper parts are mottled with dusky and grey.

OPHIDIA.

HYPSIRHINA MACULATA, sp. nov.

Hypsirhina *ad* H. chinensem *affinis, sed squamis in* 25 *nec* 23 *series regulares longitudinales ordinatis, scutis ventralibus ad* 125. *Caput breve, rostrum truncatum, corpus robustum, cauda compressa. Scutum præfrontale unicum parvum, singulis postfrontalibus magnitudine secundum; præoculare unicum, postocularia duo. Color fusco-cinerascens, nigro-maculatus, abdomine albescente, fascia fuscâ longitudinali utrinque ad margines scutorum ventralium ornato.*

Habitat *in Pegu Burmanorum.*

Head short, very little broader than the neck, muzzle broad, square, as if truncated, body stout, tail short compressed. Scales polished, rhombic, in twenty-five very regular series. Ventrals narrow 125, anal bifid, subcaudals in 45 pairs.

The rostral, which just reaches the upper surface of the head, does not occupy much more than half the anterior margin of the upper jaw. The single anterior frontal is nearly as long as broad, and is a little smaller than each of the posterior frontals; vertical fully twice as long as broad, elongately subpentagonal; occipitals a little longer than the vertical. Loreal trapezoidal, on one side the loreal is partly united to the postfrontal; one præ-, two post-oculars. Temporals 1 + 2. Upper labials 8, gradually increasing in size to the 7th; the eighth is small and no larger than the adjoining scales, the 4th enters the orbit. Only one pair of large chin-shields, the posterior pair scarcely exceed the adjoining scales in size.

Colour blackish ashy with a row of large irregular-shaped black spots down the back and another rather less in size, but each spot including several scales, down each side; a blackish band down the margins of the ventrals caused by the dark edges of the shields and of the first row of scales on each side.

The specimen is 12 inches long, of which the tail measures 1¾. It was collected by Dr. Baker in Pegu, I believe, in the neighbourhood of Bassein, and sent to me with some other snakes for examination by Captain Spearman.

This *Hypsirhina* appears separable from all other species by the larger number of rows of scales. The scales in this genus are so regular, that I think even a single specimen affords sufficient evidence of distinction, and the Pegu snake is further distinguished from *H. chinensis*, its nearest ally, by having a smaller number of ventral shields. In *H. chinensis* there are 23 rows of scales round the body and 150 ventrals. I have not access to a specimen of *H. chinensis*, and so far as I am aware no figure of this species has been published, so I cannot tell whether *H. maculata* has a differently formed head. From the two species of *Hypsirhina* previously recorded from Burma and India, *H. plumbea* and *H. enhydris*, the present form is at once distinguished by its much blunter muzzle and smaller præfrontal shield, and by its coloration, besides the much more numerous rows of scales.

Dipsas trigonata.

A young snake, obtained by Major Mockler at Gwádar in Baluchistán, appears to me to be nearer to this species than to any other, although I cannot feel sure that it is correctly identified, for, although I can detect no distinction in the shields, the head appears narrower, less triangular, and peculiarly coloured, and the muzzle broader than in other examples of the species. The locality is of interest also, as it is much farther west than this snake has been previously found, Gwádar being about 200 miles west of the British frontier, and the occurrence on the Baluchistán coast shews how thoroughly terrestrial a form this species of *Dipsas* is, for there is not a single tree and scarcely a bush to be found near Gwádar, which is merely a fishing village on a barren spit of sand, between a rocky promontory and the mainland.

The length of the specimen is 12 inches, of which the tail is 2½. Ventrals 230, subcaudals 92. The upper surface and side of the head are mottled with black, which prevails in front, so that the frontals, rostral, and anterior labials are entirely black or blackish. On the body there are the usual rather irregular transverse dark-edged whitish elongated spots.

Xenurelaps bungaroides.

This snake has hitherto only been reported from the Khási hills, where it appears to be rare.* In 1878, I captured a specimen close to Dar-

* Günther, Rept. Brit. Ind. p. 345; Jerdon, P. A. S. B., 1870, p. 82.

jiling, and, subsequently, Dr. Anderson obtained another from the Government Cinchona Plantation in Sikkim.

The specimen taken by myself is much larger than the type, and measures 32 inches in length, of which the tail is 4. It was caught in the dusk of evening on the road round Birch-hill, at an elevation of rather less than 7000 feet above the sea. When taken it appeared sluggish and made no attempt to bite.

Hydrophis lapemoides.

A specimen, sent from Gwádar in Baluchistán by Major Mockler and collected, doubtless, on the Makrán coast, agrees so well with Dr. Günther's description of *H. lapemoides* that I have no doubt it must be assigned to that species. The dorsal scales, in the posterior part of the body especially, have a short tubercular keel, but on the lateral scales there is only a central tubercle. Thirty-five black rings round the trunk, the anterior rings imperfect below. Length 15½ inches, of which the tail measures 1·6 and the cleft of the mouth 0·4.

Hydrophis latifasciata.

A specimen, agreeing very fairly with the description of this species (of which the type was procured from Mergui), has been sent to me by Captain Spearman from Pegu. There are, however, one or two characters which seem to shew a tendency to a passage into *H. coronata*. The lateral scales on the hinder stout portion of the body have a slightly elongated tubercle rather than a keel, and the ventrals bear two such tubercles. Even on the dorsal scales, the keel does not extend half the length of the scale. The coloration agrees with the description of that found in *H latifasciata* so far, that the yellow rings are very imperfect and the blackish colour covers a much larger portion of the body, the whole of the lower part of the anterior two-thirds being black and the yellow rings being only faintly traceable across the band throughout the thicker part of the trunk, they extend in general across the neck, though narrower on the upper surface, and appear in the anterior part of the body as well-defined transverse spots, but on the thicker portion and tail they are only conspicuous as elongated oval spots with indistinct edges along the sides. There are 56 of these imperfect yellow rings on the neck and body, 9 on the tail. Length 27 inches, neck about one-third of the whole, cleft of mouth 0·3 inch, tail 3½.

XVI.—*Notes on Stone Implements from the Khasi Hills, and the Banda and Vellore Districts.*—*By* John Cockburn, *Late Curator of the Allahábád Museum, Officiating Assistant Osteologist, Indian Museum, Calcutta.*

(Received 1st July; read 6th August, 1879.)

(With Plates XIV, XV, XVI.)

Stone Implements from the Khasi Hills.

Stone implements have from time to time been found in the Province of Assam, but the specimen figured in Plate XIV (figures A, A[1]), is unusually interesting, as being the first stone implement found *in situ* on the Khási Hills. The only previous record of a stone implement from the Khási Hills I can find, is by Col. Godwin-Austen, in P. A. S. B. for 1875, p. 158.* This specimen was picked up on the surface of the road, on the bridge near Col. McCulloch's house at Shillong, and no one who knows the locality can doubt that it had been dropped accidentally, probably from the pouch of some Khasia, a people who venerate celts as relics. Specimen B, (Plate XIV, figs. B, B[1]) which I purchased from a Khasia, had a small portion scraped off. This, I was told, had been administered to a sick child in a draught of water. The first specimen (A), which measures roughly 3′ 50″ in length, by 1′ 65″ in width, is made of a tolerably hard argillaceous slate. It was dug up at Shillong in December, 1877, on the site of the house at present occupied by Brigadier-General Nation, in the presence of Col. A. Tulloch, then in command of the 42nd N. I., and Lieut. H. Stevens, Adjutant of the Regiment. These officers were superintending a working party of the men of their Regiment who were levelling the site, when one of the men, a Ghurka, came up to them with the celt in his hand, all incrusted as it was with clay, and said it had just tumbled out of a clod he had broken up. On the specimen being shown to me, I at once pronounced it to be a genuine celt, in spite of the soft material of which it was made. I visited the place the same day in company with these gentlemen, and was shown the spot where it was found. This was nearly four feet below the surface in clay. This clay overlies a peculiar sub-gneissose sandstone, and from sections I had an opportunity of observing on an adjoining site about 300 yards north-east of the General's house and elsewhere close by, it averages from five to seven feet in thickness.

I shortly after got specimen (B) from a highly intelligent Khasia in my employ; he said he had found it near Nongpo on the Shillong and Gauháti road. There can be no doubt as to the authenticity of this specimen, which is made of the same material (slate) as specimen (A,) and has

* For two other instances of stone implements in Assam, see P. A. S. B., 1872, p. 136.

a similar weathered coating. I cannot certify to the locality, for my Khasia friend had decidedly loose notions as to the value of truth, but am of opinion that it was also found on the Shillong plateau. In shape, it somewhat resembles the small Jade specimens from Yunan and may be considered as a form grading into the shouldered type of celt. I may mention that it bears a good deal of resemblance to the chisel used at the present day in file cutting. These celts of slate could hardly have been used as anything else but agricultural implements, hoes &c., as pointed out by Col. Godwin-Austen; but I would suggest that besides being used as instruments for digging up roots &c., fixed in a rude horn or wood handle, the chief use of celts of the smaller type from 6″ to 2″, made of greenstone or chert, was *for flaying animals.* The specimen figured at p. 251, Fig. 161, of the *Catalogue of Antiquities of the Royal Irish Academy* well illustrates how these small celts were handled, probably fixed with some hard resin, like the "black boy" gum of Australia, in a cavity scooped beneath the burr of a shed antler with a few inches of beam attached, so as to form a small handle. I was struck with this idea from the facility with which I have seen Chamars in the Cawnpore District, skin Nilgai *(Portax tragocamelus)*, with their rude *khúrpas* (an instrument like a flat metal celt, fixed into an obtusely angular handle, made of a branch of a tree and used chiefly for scraping up grass). I have not the least doubt that their aboriginal ancestors used these small celts, which were similarly handled, as deftly for this purpose in their day. I would myself undertake to skin in a couple of hours an animal the size of a heifer with a celt handled and sharpened, and the assistance of a few flint flakes or shells.*

* I find I have been perhaps anticipated in the above remarks by Mr. V. Ball, in a paper read before the Royal Irish Academy on the 30th of November, 1878, but of which I did not see a copy till June last, while my paper was written in the previous November. I here copy this portion of Mr. Ball's paper. "There is one class of stone implements unsuited to any of the above-mentioned purposes, but which being provided with sharp edges it seems very probable were used as skin-scrapers. In connexion with this, I may mention that on one occasion in the Satpura Hills in the Central Provinces, having shot a bear I gave the carcase, with some knives to the people who had brought it to camp, in order that they might take off the skin. These people belong to a tribe who always carry a very small well-sharpened iron axe of a form I have not seen elsewhere. After working for a short time with the knives, they discarded them for the axes, which they removed from their wooden handles, and then placing their thumbs in the holes grasped them firmly in their fingers, and continued the flaying with astonishing rapidity. In a similar way, I believe that the scrapers of stone may have been used for the preparation of skins, which when rudely dressed afforded the only clothing of these early inhabitants." I may here remark that these small curved axes are used throughout Bundlekhand, and that I always carried one myself for many years on shooting excursions.

In connexion with the subject of stone celts, I may mention that it is not generally known that the natives of Upper Assam use a genuine metal celt at the present day. The only record I can find of a somewhat similar implement is in the P. A. S. B. for 1871, p. 83, where a celt of this kind is spoken of as used in Arakan, fixed on a long bamboo handle.

This simple but highly efficient Assamese axe somewhat resembles a modern African axe figured by Sir John Lubbock at p. 28 of the 3rd edition of *Pre-historic Times*, and is almost identical in principle with another modern African axe, fig. 256, p. 370, *Cat. Ant. R. I. A.* It consists of a moderately stout handle of a dark and heavy wood, slightly curved upward at the haft end, where it expands into a hard natural knot. Into this knot is inserted at an angle, a tapering chisel-like blade of iron about 2·25 in. wide at the cutting edge, tapering to a point, and about 8 in. long. An axe of this kind will stand three or four years of hard work without splitting, and the dexterous and efficient way in which it was used excited my admiration. A family or party consisting of five or six males will fell and clear three acres of dense forest in two months, working at leisure. I observed this kind of axe used from Dumduma to Saikwah Ghat on the Sadiya Road, in the hands of Muttucks, Ahoms and Miris. Occasionally these tribes take contracts from tea-planters to clear forest, and, I have been informed, prefer their own tools to the best English felling axes. On one occasion I myself had to fell a considerable sized tree near a clearance at Dollah, near Sadiya, for the purpose of obtaining the eggs of a wood-pecker, and set to work with an English axe. The tree was quite 20 in. in diameter, and I had not gone two inches into the wood, when a man came up bearing one of these primitive axes, and volunteered his assistance, refusing at the same time the proffer of my axe, on the grounds that it was unnecessarily weighty, too broad, and formed a thick and clumsy wedge. In a quarter of an hour he had the tree down, and in a short time more the glistening eggs were in my hand. This iron Assamese celt, which, if found elsewhere, severed from its handle, would be considered of quite the same type as the narrow bronze celts considered by some Antiquaries to have been chisels, suggests the reflection that fig. 252 A. of the *Cat. Ant. R. I. A.*, which has been accepted all over the world as the method in which the flat wedge-shaped celt was handled, more particularly since its reproduction in Sir J. Lubbock's popular and interesting work *Pre-historic Times*, (see p. 25, 2nd edition,) is not quite correct.

In this figure the taper point and a proportion amounting to nearly one-fourth of the instrument, is seen projecting above the handle, while

a cross ligature of tendon or cord gives additional security to keep the head from falling out and the handle from splitting.*

That some celts were so handled has received additional confirmation from a Plate in Fergusson's *Tree and Serpent Worship*, where a man, considered an aborigine†, is represented cleaving wood with a celt, which, as the cross ligature and the projection of a portion of the metal above the handle show, was handled in the manner suggested in the *Cat. Ant. R. I. A.* But figs. 274 to 251 in that work, and all bronze celts of the long narrow type were, I am inclined to think, hafted imbedded in a knot as in the modern Assamese axe. Flat copper celts of exactly the same type as represented in the bas-reliefs of the Sanchi Tope have been found in the Mainpuri District, in the Gangetic Duáb‡ and also in the Balághát District, hardly more than a foot below the surface, indicating their use at a comparatively modern date.§ Copper or bronze (?) implements were, I am inclined to think, in use all over the Duáb in the second century after Christ, in conjunction with iron, which was either too costly to be procured by the poorer classes or too valuable to manufacture agricultural implements of. At this era I would assume that certain tribes of aborigines who yet maintained their independence, in impenetrable jungles or hills in various parts of the country, continued in or were slowly passing out of a stone age. The chert flakes and arrow heads found in Bundelkhand *on the surface* possibly originated at this time, as well as some of the numerous polished celts found in this part of the country.

We know how rapidly savage communities pass from a Stone age into an age of Iron, from the evidence of Capt. Cook regarding the New Zealan-

* A remarkable find of copper implements at the village of Gungeria, Mhow taluk, Bálaghát District, is recorded in P. A. S. B. for May, 1870, (with a Plate), when 424 copper celts and some silver ornaments were found a few inches below the surface of the ground. I would suggest that specimens 1 A, 1 B were socketed as in the Assamese axe, while 3 A, 3 B, 3 C were handled after the fashion shown in the railing at Sanchi, and as divined in the Cat. of the Royal Irish Academy. With regard to the very extraordinary silver plates found at the same time, I would throw out the suggestion that they were human ornaments, and not bovine. The only instance of a similar silver ornament worn among savages at the present day, is the possibly analogous thin silver plate, worn on the forehead by the Mishmi women (see Dalton's *Ethnology of Bengal*). It is improbable that the race who made these ornaments venerated the cow at all.

† Fergusson calls these people Dasyus and elsewhere speaks of them as hated and despised aborigines.

‡ P. A. S. B., 1868, pp. 251, 262.

§ A flat copper celt of exactly this oblong type has been found associated with Buddhist remains in the Chaubara mound, Muttra. General Cunningham, *Report of the Archæological Survey*, 1871-72, p. 16, Vol. 2.

ders, and from what we see of the existing Andamanese. Nevertheless, I think we may fairly assume that stone continued to be employed for flakes and arrow-heads &c. long after iron was first introduced. The North American Indians long continued to use flint and jasper for arrow-heads when they were in the possession of abundance of iron tomahawks and knives, and even firearms. Catlin in his work on the North American Indians records how the Western hunter using a gun on horseback was unable to compete with the Red-skin using the bow and stone arrow in the chase of the Bison, and how this flint-tipped arrow was frequently driven right through the ponderous shoulders of the mighty beast, by the sinewy arm of the savage.

There is no reason why a savage should not be able to fell a tree with a good big celt such as the fine specimen, 10 inches long shown in Plate XVI, (fig. G,) sharpened and handled. In fact, marks corresponding to such as would be made by a stone implement, have been discovered on ancient piles in the Lake-dwellings of Europe, clearly showing that such implements were used for cutting wood.

Stone Implements from Banda.

Abú'l Fazl, in the Aín-i-Akbari, describing the fortress of Chunár writes: "Near this fort are a race of people who go quite naked, living in the wilds, and subsisting by the use of their bows and arrows. In those wilds are also elephants." I have tracked the Sambar with the descendants of these savages, the modern Kols, not far from Kirwí, a great locality for celts. This brings me to the subject of the Banda implements. None of these celts have been found in their original situation by Europeans, and there seems a good deal of mystery attached to the circumstance of their extraordinary abundance in this tract, and the comparative rarity of such lithic remains elsewhere. I am of opinion, however, that they will be similarly found (on shrines and under trees) nearly as numerous in other parts of the Peninsular of India, inhabited by aboriginal races to within a recent period. Mr. H. P. LeMessurier was the first to draw attention to these remains in Bundelkhand, in P. A. S. B. for February, 1861. He was of opinion that they had all been found within a few miles of where their finders had deposited them, an opinion I endorse for reasons to be stated further on. He also personally discovered a chert arrow-head of an European type, twenty-eight miles east of the Cachai Falls (Tons), a discovery of the greatest interest.

In the Proceedings for June, 1862, J. A. S. B., XXXI, p. 323, Mr. W. Theobald, in a short paper, which continues to be the only memoir of importance on the subject, added considerably to our knowledge of these Banda

implements, figured a series, pointed out the principal types, and further extended the area of their prevalence to 200 miles east of the Tons river. He accounted for their abundance in the vicinity of Kirwí by the hypothesis that it was due to some "superstition which induced men of old time, to collect these relics of a still older age, and convey them to the shrines and localities where they are now so abundant, so that celts collected over thousands of square miles are now accumulated about Kirwí and its environs." This supposition of Mr. Theobald's agreed well at the time with the scarcity of other stone weapons in this area, compared with celts—one stone hammer, and a single chert arrow-head being alone recorded by Mr. LeMessurier. In the light of our present knowledge of stone remains within the Peninsular area, I would modify this theory of Mr. Theobald's. In February 1878 I found a number of chert flakes on the eroded surface of a rain-washed field, situated on the bank of a small stream, only a couple of hundred yards away from a tope near the village of Hatwah, in pargana Chibun, district Banda. They were all of a small type, and exactly resembled those from Jabalpur in the Geological Museum. Two of them were perfect, the remaining few were fragments, which when restored would have been from three quarters of an inch to an inch and a quarter in length. Unfortunately they were all lost. Regarding the use of these flakes there can be very little doubt that they were used, held between the fingers and thumb, in making the first incision down the mesial line in the process of skinning, the remainder of the operation being completed with the comparatively blunt celt. The discovery of these flakes led me to make more extended enquiries on the subject than hitherto from natives, some of whom were Bráhmans of intelligence, whose families had been settled in the villages around for generations. The more intelligent of these men, while stoutly maintaining the great antiquity of the celts, and that they (the Bráhmans) had remembered the celts as children under the trees where the implements still remained, and that their fathers had handed down the same story to themselves, admitted that celts continued to be found to the present day; one of the Bráhmans interrogated had found one himself, while the others had all heard of, or seen instances of celts being found in their own village fields. Some of the ignorant were unable to account for the reverence with which they regarded these stone remains; evidently having a sort of confused idea that the celts were in some way connected with the Phallic emblem worshipped by the Hindus. Others considered the celts thunderbolts, calling them—"*Bijli ka puthul*"—lit. "stones of the lightning," an idea which prevails in every quarter of the globe.

I can confirm what Mr. Theobald says regarding the ability of the

natives to recognise the veriest fragment of a celt, pieces in fact which have been declared by educated Englishmen to be fragments of pebbles. The people, however, seem to regard a smooth surface on some part of the implement as an indispensable test of the authenticity of a celt, and failed to recognise flint knives. This would account for the singular absence of palæolithic weapons among these remains in Banda. A seeming exception to this rule is the heart-shaped type of celt, of which No. 4 is a fragment, but these, though chipped, invariably exhibit the best cutting-edge, when perfect, of any I have yet seen, and this is also Mr. Theobald's experience, see fig. 4, Pl. II, of his paper. The same remarks apply to the elongated chipped fragment, No. 13, of my list, (Plate XVI, fig. H) which is polished on the bevelled surfaces forming the edge, and is yet sharp. The stone hammer was probably retained by its finder for the same reason. This hypothesis of mine, is, however, open to objection, based as it is on the absence of palæolithic implements in a tract which yet remains to be carefully explored.

The majority of my specimens were picked up under Pipal trees, sometimes on the road side, but more usually growing on the high bunds of the tanks so common in Banda; a number were removed by me from off a huge Phallus, where they lay in the groove of the female emblem. Specimen No. 2, I found on a stone slab in a ruined temple; Nos. 5 and 7, I found on a mud altar with the hammer described further on. Others are often placed in the fissures and clefts of trees. It is curious that precisely the same idea exists in this part of India on this last point as on the continent of Europe, where the peasantry place celts, called "thunderstones" (as I have often heard them called in Banda), in the clefts of growing trees. I have twice dug out celts with my hunting knife, which were so grown over by Pipal trees; on one of these occasions, only the conical tip was visible! With regard to the finding of these celts by natives, most of them have, I believe, been found in excavations a few feet deep; some have doubtless been turned up by the plough; a large proportion again have been found in watercourses or streams, into which they had been washed along with the soil; others have been found on the eroded surface of fields. In one instance alone did a celt picked up by me show unquestionable traces of having been lately deposited under the tree where I found it. This specimen, which I think I gave to Mr. G. H. M. Ricketts, C. S., C. B., had red sand adhering to it in compact lumps, so hard as to justify the belief that it was part of the original matrix in which the celt was found.

The accompanying table gives details of the types found in Banda, by myself, and my brother William Bruce Cockburn, who first drew my attention to them, has himself collected a large series, and has aided me very materially in searching for them personally.

Table giving Weights and Dimensions of Celts from Banda.

No.	Length.	Greatest Width.	Weight. lbs.	Weight. oz.	REMARKS.
1	10·45	4·20	5	2	This magnificent specimen was found by my brother W. B. Cockburn, in the village of Lohra, Pargana Darsenda. I believe it is the finest polished celt of this type found in India. Material Diorite. (Plate XVI, fig. G.)
2	6·66	2·70	1	5	Found in a ruined temple 5 miles from Hatwah, Do.
3	4·50	2·75	1	4½	Of a peculiar massive type. Do.
4	5·41	3·75	1	4½	Chipped fragment of heart-shaped type made of fine-grained trap. Two of the most highly finished specimens I have yet seen from Banda were of this type. I gave them to a brother antiquary and regret not having preserved drawings of them.
5 (D)	4·12	2·90		11	Of fine-grained black trap. Found on mud altar with stone hammer.
6	4·25	2·86		9	Of intermediate size. Diorite.
7 (E)	3·50	2·25		6½	Found on mud altar with stone hammer. Diorite.
8	4·85	2·20		11½	Of long narrow type, very close to those from Vellore. Material Diorite.
9	4·50	2·25		8	
10	2·95	2·		4	Of smallest type. Diorite.
11	2·50	2·05		3¾	
12	5·80	3·70		10	Flat celt ·75″ thick of indurated shale. This is a very interesting and instructive specimen.
13	4·30	2·		6¼	Elongated chipped fragment of fine-grained trap exhibiting a remarkably good edge. Possibly used in the hand in flaying, very much as an anatomist uses the end of his scalpel more for detaching than cutting. (Plate XVI, fig. H.)
14	3·25	2·13			Pear-shaped implement of sandstone bearing evidences of having been subjected to heat. Interesting as being the first implement of this material from Banda.

The above specimens, with a series of 20 more, chiefly duplicates of these types, are in the Geological Museum, Calcutta. A and B (Plate XIV), from Shillong, are in the Indian Museum, as is also a remarkable specimen of stone hammer, which requires a detailed description.

This stone hammer (Plate XIV, fig. C) was picked out by me in February, 1878, off a mud platform, or altar, four feet high, built at the angle formed by two mud huts, three miles south of the village of Hatwah in the District of Banda. There were quite a heap of stones on this platform, most of them water-worn pebbles, and two celts (5 and 7, of Table). There is no specimen of this type of hammer, or more correctly oval tool-stone, in the Geological Museum, and, as I can find no mention of a similar specimen in Mr. Ball's tabulated list of stone implements, I believe it is the first specimen of its kind found in this country. Similar implements have,

however, been largely collected in Europe, and my specimen is a facsimile of fig. I, pl. I of Prof. Nilson's work on the Stone Age, and also closely resembles an Irish specimen figured in the *Catalogue of Antiquities in the Royal Irish Academy*, p. 94, fig. 75. The Banda specimen is obviously a water-worn pebble of a red quartzite, with a tolerably deep hole in one side. It seems that water-washed stones were similarly utilized in Europe during the stone age, for Mr. Wilde says, in reviewing the Irish collection, that "some of these stones are natural-water-washed pebbles, others are evidently shaped by art." Regarding the indentation or hole, which is sometimes found on one side only, at others, in precisely similar specimens, on both sides, the Editor of the Catalogue is of opinion that it is the first step in the formation of a hole, which it was the intention of the maker to carry right through, and fig. 76, which yet more closely resembles my specimen in size and outline than fig. 75, with a large series in every stage of manufacture, clearly shows this. There can be very little doubt that these so-called tool-stones were used as hammers for cracking small bones, nuts &c. and for lighter work generally, during what must have been a protracted process, the boring. My Banda specimen bears evident marks of the effects of percussion at either end, which it would be difficult to account for otherwise, and from the singular convenience of hold it affords when held between the finger and thumb, it was probably so held and used.

Stone Implements from Madras.

Stone implements of a neolithic type have hitherto been remarkably scarce in the Madras Presidency, there being only one recorded instance in the Society's Journal of a polished celt having been found within this area, (P. A. S. B., 1868, p. 59.)

I have since had a series of polished celts from Vellore of quite the same type as the Banda celts.

This collection of polished celts from Vellore is of the greatest importance. Mr. V. Ball, in his paper "On the Forms and Geographical Distribution of Stone Implements in India," considers the whole of Southern India (coloured red in his map,) as productive of palæolithic implements of chipped quartzite only. Up to the time Mr. Ball wrote, there had only been a single recorded instance of a polished celt having been found within this area, (P. A. S. B., 1868.) After his essay had been printed, Mr. Ball examined a series of polished celts from the Shevaroy Hills, in the British Museum, but he remained inclined to consider this *find* another instance of an outlier. I leave it to the reader to consider whether the accumulated evidence collected now is not quite strong enough to seriously affect Mr. Ball's theory.

The series of ten now exhibited were found on a low rude sort of stone table, under a tamarind tree, near a Mallayam temple, in the

village of Tulleh of the Vellore taluq, North Arcot district, by my friend Flo. W. Tucker, Esq., now of Naini Tal, who was then in the Madras Presidency on Famine duty.

The Vellore celts closely resemble others of the long narrow type from Banda (specimens 8 and 9), and from the red tinge communicated to the surface of these implements, it is probable that these Vellore specimens have also been derived from the surface of laterite beds like the ruder weapons of chipped quartzite from the same district. Three of these Vellore implements are figured in Plate XV, figs. D, E, F.

There are three forms of stone implements, the uses of which are considered by many more or less problematical. 1st, The oval tool-stones and mauls,* of the former of which the specimen described above is a typical example. 2nd, Sledge hammers of stone, such as are held in the hands and used in working metals by African races at the present day. Implements of this type do not appear to have been discriminated in Europe where they doubtless occur, but a very fine Indian specimen from Powari, east of the Sone river, is figured by Mr. Theobald in pl 1, fig. B, J. A. S. B., Vol. XXXI, (see p. 326 of his paper). 3rd, Spindle whorls, which when found perfect (made of bone) have not exceeded $2\frac{1}{2}$ inches in diameter; but from what I have seen of their use among modern natives, I believe that stone implements of this type from 3 in. to $3\frac{1}{2}$ in. in diameter might well have been so used. 4th, Ring stones or stone bracelets.† This I believe to have been the real use of the large type of flat round stones with perforations large enough to admit the small hand and wrist of a savage. Certain Indian castes at the present day with a strong infusion of aboriginal blood in their veins, Chamars and Pasis in the N. W. P., continue to wear ponderous bracelets on the wrist made of a composition like bell-metal. I have seen these ornaments quite 5 in. in diameter with a triangular section an inch and a half wide at the base. There is what I take to be a typical specimen of this Indian stone bangle in the Geological Museum, which exceeds an inch in thickness on the inner side of the circle, and is bevelled to a sharp edge on the margin.‡ The aperture is sufficiently large to admit a small hand. I

* A circular perforated type of maul surrounded by a groove, of which two were found at Chidizi, in Balúchistán, and described in the Proceedings of the Asiatic Society for July, 1877, should be included in this list.

† A fine specimen of ring stone of jade from Burmah, said to be ancient, is described in Vol. I, p. 328 of the *Indian Antiquary*. It measures 4·3 in. in outside diameter, with a hollow in the centre 2·2 in. across, leaving the circle 1·1 in. broad, which is, however, only half an inch thick on the inner side and is bevelled to a sharp edge on the margin.

‡ This specimen has been figured at Plate VII. of Vol. X, Pt. II of the *Memoirs of the Geological Survey* (The Geology of Pegu), and was rightly considered an armlet by Mr. Theobald.

have seen native women screw their hands into bangles barely over two inches in inside diameter. Those with the perforation only 1½ in. in diameter were probably in the course of manufacture. The peculiar conical nature of the orifice on both sides in these specimens is due to the necessarily rotary motion imparted to the borer by the hand and arm. These holes were usually begun on both sides, for the reason that they would be easier to enlarge when so made.

XVII.—*The Ravages of Rats and Mice in the Dakhan during the Harvest of* 1878-79.—*By the* Rev. S. B. Fairbank, D. D.

Some years ago, when itinerating in the vicinity of the Perá River, near Ahmednagar, I was astonished at the stories told me about the destruction of whole fields of *Jawárí (Holcus sorghum)* by rats. I went to the fields, and, though it was after the harvest so that I could not see the progress of devastation, I found the ground thickly dotted with small holes, and marked in all directions by the paths the rats had made, principally in passing from one hole to another. I tried to get specimens of the rats, but failed, as I was then unacquainted with their habits, or perhaps they had gone elsewhere, as the people claimed they had. They must have been the Mettáḍ rats *(Golunda mettada)* of whose ravages Sir Walter Elliot wrote fifty-three years ago.

Since I saw those fields I have sometimes heard of injury done to crops by rats, but of nothing very extensive, till their ravages that began at the end of 1878, when the *Rabí* (winter) crops began to ripen, attracted the attention of everybody. There had been destruction before, but when, daily, large quantities of green Sorghum stalks were brought to Nagar for sale, and it was known that they had the night before been cut down by rats, everybody wakened up to the importance of the subject. At first stalks were cut down here and there in the fields, but more were cut as the days went on. And afterwards fields were suddenly attacked and destroyed in a few nights. When food became scarce where they were, the rats gathered their forces and an army of them invaded fields that had not been harmed before and quickly destroyed them. In some places they did not cut down the stalks, but climbed them and gnawed off the ears of grain. Some of the ears thus cut off were eaten or partially eaten where they fell, and some were hauled into their holes by the rats and stored there. A good deal of the grain thus stored was dug up and used for food. The farmers, finding that the rats would not allow their grain to ripen, gathered as many as they could

of the unripe ears, and, although the grain was still in the milk stage of its development, when dried it was fit for food. They thus saved an eighth or a sixteenth of the crop they had expected to harvest. The rats also attacked the growing wheat and much of that was harvested while the grain was in the milk, but the dried unripe grain was shrivelled, small in quantity and poor in quality. Gardens of egg-plants and other irrigated vegetables were found by the rats and the fruit was eaten by them while it was still immature. Even carrots were eaten, and so was lucerne in the hot season, when their supply of *harayáli* grass *(Cynodon dactylon)*, which is their usual food, was exhausted. The patches of melons and other *cucurbitaceæ* that are grown in the moist sand of river beds during the hot season, were nightly visited by the rats, and each melon was eaten before it was ripe enough for the use of man.

These ravages extended over several thousand square miles. The Párner, Shrígonde and Karzat tálúks and part of the Nagar tálúk in the Ahmednagar Collectorate, the Indápúr tálúk of the Púna Collectorate, all the Sholápúr Collectorate and the northern third of the Kaládgí Collectorate, as well as the adjoining Native States, were ravaged, though the crops were not so much injured along the N. E. and S. W. borders of this belt as they were in the middle of it. How far the plague extended to the E. and S. E. of the region specified above I have not been able to learn. Groups of villages in other parts of the Ahmednagar Collectorate, especially to the N. E. of Nagar, suffered in the same way. The region particularly specified extends from N. W. to S. E. for about 175 miles, and is from 40 to 80 miles wide. I travelled through a large part of it in May and June, and found that most of the villagers had already consumed what the rats had left, and in whole groups of villages there was no grain that could be purchased which had been raised there. All that I could find was imported grain and was mostly the flat kind of Sorghum that is brought from Jabalpúr. The people had been living, for weeks, mostly on wild seeds and sweet potatoes (using the leaves as well as the roots) which had been raised by irrigation. Near Sholápúr there was some *bájarí (Holcus spicatus)* left of the *kharif* (autumn) crop of 1878, which was for sale ; and *náchaní (Eleusine coracana)*, to the use of which the people were unaccustomed, was also brought from the Madras side and exposed for sale. The wild seeds of *Indigofera linifolia*, *I. cordifolia* and *I. glandulosa* were also sold, the price being about two-thirds the price of Sorghum millet. The seeds of some malvaceous weeds, such as *Abutilon indicum* and *Hibiscus* sp. ?, were also used for food, but I found none exposed for sale. I looked in the fields for specimens of the *Tradescantias* and *Commelinas*, the seeds of which were prized so highly in the famine of 1877, but could find none. It would seem that they had been nearly extirpated.

The people attribute these ravages to the Jerboa rat *(Gerbillus indicus* or *G. cuvieri)* which they usually call the *pándhará undir*, that is, the *white rat.* The white belly of the *Gerbille* is often distinctly seen when it is jumping about in the dusk of evening. They say there are also *Kálé undir*, that is *black rats*, among the robbers, but that they are comparatively few. These are the *Kok* or mole-rats *(Nesokia indica)* which are not black but only dark and much of the size and colour of the brown house-rat *(Mus decumanus)*, though they are at once distinguished by their broad bluff muzzle, and are much heavier. The people suppose that the Mettáḍs, which are of still another group and are for their size more destructive than either of the above, are the young of the others. Jerdon calls the Mettáḍ *(Golunda mettada)* "the soft-furred field-rat." Most would rather call it the large-eared field-mouse. These three species include most of "the horrid rats" which have increased so astonishingly, and thus have been able to ravage so large a region. In some places the house-rats and mice, and other field rats and spiny mice helped to devour the crop.

I wrote of these matters briefly to Mr. W. T. Blanford, who is our authority on matters pertaining to the Mammalia, and I give an extract from his answer, as follows :—"By one of the last mails I had a letter from Sir Walter Elliot (who, you may remember, was the first to collect the rats and mice of the Dekhan and to notice the injury committed by them,) referring to the plague these animals had been, and suggesting that *Mus mettada* was again the depredator. It is new to me to hear of *Gerbillus indicus* (or rather the Southern *G. cuvieri)* as a serious nuisance." But though I think the Mettáḍ should have the credit of learning to climb the Sorghum stalks and to cut off the ears of grain, there is no doubt that the *Gerbilles* have been the most numerous and so the most destructive this year. They have been taken in the act everywhere. And for the sake of the crops to come, it is particularly a matter of regret that they seem to thrive just as well during the rains as in the other parts of the year. The Mettáḍ lives mostly in the cracks and the small burrows it makes in the black soil ; and the Kok burrows in the black soil. Where the first rains that fell were heavy, the black soil suddenly swelling, so as to fill up any holes or cracks there had been in it, caught the Mettáḍ and Kok rats as securely as traps would have caught them and smothered the greater part of them. T. Davidson, Esq., writing me from Máḍha, of the Sholápúr Collectorate, on the 29th May, tells how it was there. "There was a grand slaughter of rats on Monday night and Tuesday morning. It rained 2.65 inches, and in the morning the whole black soil was covered with dead and dying rats, sticking in the mud. The people say half have died."

But the Jerboa rat makes his burrow in the light soil, in stony places,

or, if in the black soil, among bushes where the soil does not bake and crack so much, and he burrows so that his sitting-room is near the surface, though approached by passages that are deeper, and he can easily work through the roof of it if water troubles him. The *Gerbilles* about here do not seem any less numerous than they did before the rains began. At any rate they are still excessively abundant.

The people use no means for destroying these rats. They seem superstitiously afraid of still more vexing the angry divinity. So they say "The rats were sent, and if we kill them, more will come." Or, thinking that those who died in the famine have now been born as rats, they say, "We did not feed them when they were starving, and now they have come back to eat us out."

The black-winged Kite *(Elanus cœruleus)*, feeds on these rats, and is now, for the first time in my experience of thirty-three years, abundant in this part of the Dakhan. In former years I saw one or two in the course of the cold season. But this year I have seen them by dozens in a day and they are still here (in July,) and to be found all the way from Ahmednagar to Bijápúr.

XVIII.—*Notes on the Survey Operations in Afghánistán in connection with the Campaign of* 1878-79. *Compiled from Letters and Diaries of the Survey officers by* Major J. Waterhouse, *Assistant Surveyor General.—Communicated by* Major-General J. T. Walker, r. e., c. b., *Surveyor General of India.*

(With Map—Plate XVII.)

The Campaign in Afghánistán has added considerably to our geographical and topographical knowledge of that country, thanks to the zeal with which the Survey operations were pushed on by the Surveyor General's and Quarter-Master General's Departments, aided by the Political and Military authorities. No less than 13 officers of the Survey of India were employed with the three columns—7 with the Quetta Column, 2 with the Kuram Valley Column and 4 with the Peshawar Column.

The operations of the professional survey were also, with the Quetta and Kuram Valley Columns, supplemented by the work of regimental and staff officers who in some cases were appointed Asst. Field Engineers to aid in the Survey, and in others worked independently under the military authorities.

I. Quetta Column.

A large number of Surveyors being with the Quetta Column, a good deal of quite new country was explored and old reconnaissances checked and improved. The survey operations were, however, almost always in immediate connection with the military movements, and although every possible assistance and facility was freely given by the authorities, the work of the Surveyors had to be confined to a few miles on either side of the routes followed by the troops, and to fixing points from such mountain peaks as they had the opportunity of ascending.

Necessarily many of these routes were the same as had been surveyed in 1839-42, but, thanks to the advanced state of the operations of the Great Trigonometrical Survey of India, they can now be more accurately connected with the Geography of India, the connecting link being the preliminary triangulation carried on by Capt. Rogers, R. E., in the early part of 1878 and consisting, as stated in the *General Report of the Operations of the Survey of India for* 1877-78, p. 15, of an extension of the Indus Series by a secondary triangulation from the western Frontier of Sind into Baluchistán, along the line between Jacobabad and Quetta, and of a small triangulation in the Quetta Valley for the purpose of fixing the position and heights of the most conspicuous hills around, and connecting them with permanent marks which were put down for reference near the cantonments.

The survey operations with this column have consequently been based upon this triangulation. The fixed peaks on the Sulimani Range have been and will be very serviceable for the lines of survey from West to East across the great belt of hitherto *terra incognita*, between the road to Kandahár and the British Frontier.

Capt. M. W. Rogers, R. E. was attached to the advanced Force under General Stewart and carried on a route Survey from Quetta to Kila Abdulla at the foot of the Kwája Amrán Range, and thence to the crest of the Khojak Pass on the same range. He says this range was a great obstacle to the survey, extending right across the route and presenting no peaks for identification on the other side. It runs North and East, bearing 210° or thereabouts. There are in it three known passes, Khojak, Roghani and Gwája. The Khojak, the most northerly, starts from Kila Abdulla and was the one used by the army in 1839. It is about $10\frac{1}{2}$ miles to the crest or *Kotal*, which is about 7,600 feet above sea level. The first 10 miles are not difficult, but the next $1\frac{1}{2}$ are very steep, narrow and winding, and no work had been able to make it more than a practicable but difficult road. From the crest there is a very steep descent; a zig-zag camel track had been made and a straight (or nearly so) slide for guns (angle 30°); over this the field guns were lowered, but it would be almost impossi-

ble to bring them up again. To Chaman, on the Kandahár side from the crest, after the $\frac{1}{2}$ mile of steep descent, there is a gentle slope of $4\frac{1}{2}$ miles.

The country on the other side of the Khojak he describes as a plain with small hills and ranges rising from it. Towards the south-west it is a sandy desert to all appearances with no hills.

From a hill of 8,200 feet near the Khojak he observed two of his old stations Takatu and Chiltan and all recognisable peaks around, especially in front.

He then went with General Stewart to Gulistán Karez, at the foot of the Gwája pass, and traversed through the pass. He says this pass is but little known, but has always been the Kafila route. Colonel Sankey had improved it and made it a very good road, about 22 miles long with fairly easy gradients; its crest is some 700 feet lower than that of the Khojak, and native report, which says that the latter is closed every year after the first fall of snow, says that the Gwája has not been closed for 10 years. Captain Rogers visited what he believed to be the highest peak of the range, about 9,100 feet, and had a splendid view. He could see Quetta and some hills which the natives said were close to Kandahár. He carried on his traverse through the Gwája Pass *viá* Haoz and Jaktipal to Kandahár, the points he had fixed from the Kwája range aiding him greatly. He says the country between the Kwája Amrán Range and Kandahár is full of hills and ravines, flat generally and very fertile in many places.

In December, 1878, a route survey with chain and plane-table was made by Captain R. Beavan of the Survey of India, starting from Madadalari G. T. S., near the Bhandawali Post, *viá* Bugti Dera up to the point where the road emerges into the Katchi near Lehri.

At the request of General Stewart he then explored the routes on either side of the Bolán Pass with the object of finding an alternative route, and states that there is a fair track for camels from Naghesur by the Pashtal Valley to Kirta, up which a road might be made for carts at some expense, but no labour is obtainable in that part of the country.

There is also a route by the Mushkaf River from Sibi, or entering the hills by the Kumri stream near Dadur, over Takri Takht and down the Pishi stream into the Kirta (Laleji) Valley opposite Bibináni. This, however, crosses the range of hills which rise 400 or 500 feet above the plain on either side, and without tunneling it would be very difficult to make a road for carts.

The whole of the country is very stony, nothing underfoot but boulders and gravel with a small proportion of sandy soil. The hills are mostly in parallel ridges with stony plains intervening.

Captain Beavan then carried a route traverse up the Bolán Pass from

Dádur, closing on the bungalow at Darwáza. He was obliged to leave off at this point owing to want of water and absence of food for the camels. He commenced again from Quetta and carried on a traverse through the Gwája Pass towards Kandahár, by the same route as Captain Rogers, in rear of the advanced force under General Stewart, continuing it on to Girishk and thence back to Kandahár by another route through Yikchal, Kak-i-chopan, Khushki Nakhud, Atah Karez, Hadi Madat and Sangzuri.

This route survey from Quetta to Girishk has all been plotted on the scale of 1 inch to a mile, with as much detail on either side as could be managed, and a reduced map on the scale of ¼ inch to a mile has also been completed.

A survey of the route from Chaman, at the foot of the western side of the Khojak Pass, to Kandahár, *viá* Gatai, Mel Manda, Abdul Rahman ka Kila and Mand Hissar, in all 77¾ miles, was made by Lieut. J. Hobday, S. C.

From Quetta, Lieut. Gore, R. E. was engaged about the beginning of March in making a survey of the Pishin Valley on the scale of 2 miles to an inch, assisted by Captain Maitland of the 3rd Sind Horse, Assistant Field Engineer. This survey is based on an independent base near Gulistán Karez and connected with Captain Rogers' triangulation in the neighbourhood of Quetta.

Lieut. Gore describes the Pishin Valley as practically dead flat and upwards of 25 to 30 miles wide. He had some difficulty in obtaining suitable points, as there is a singular want of well-defined and recognisable peaks on the borders of the valley itself. On the eastern side of the valley along the foot of the Ajiram range the ground is greatly broken and cut up, water is scarce and the country is inhabited by nomad Kakars.

In conjunction with Captains Heaviside and Holdich, Lieut. Gore fixed points across the northern end of the valley, in order to connect his work in Pishin with the survey of the Thal Chotiali Route made by the latter officers.

Early in April, Major W. M. Campbell, R. E. went from Quetta with a detachment to Shoráwak and made a route traverse with compass and perambulator of about 157 miles through Ispintáza, Hisábat, Bádalzái, Zabardasht, Shoráwak Karez, Iltáz Karez, Issurkai, Ispinkai, Chichizai, Showd, Panchpai, Shorad, Khanak, Barg and back to Quetta. This traverse, though rather rough, is valuable as being almost all through nearly unknown country, and it helps to mark some very important features, for instance, the edge of the great desert, the course of the Lora, the Khán's boundary &c. It gives the position of several ranges of hills and a fair idea of their nature and direction for some miles on either side.

Major Campbell was also able to make observations for latitude and longitude at several points and to connect his traverse by triangulation with reference to one of Captain Rogers' points, Chiltán, a high peak near Quetta and visible at great distances.

On his return to Quetta Major Campbell arranged with Capt. Rogers for determining by telegraph the difference of longitude between that place and Kandahár.

Shortly after the arrival of the army at Kandahár Captain Rogers accompanied the expedition to Khelát-i-Ghilzái and on the march carried on his traverse continuously, fixing as far as possible the positions and general features on each side of the Tarnak River. The Force marched up the right bank keeping near the river; the hills on both sides, Captain Rogers says, are pretty continuous, smaller and more broken up on the left bank and approaching more nearly to the stream. On the right bank the hills are more continuous and are from 6 to 10 miles from the stream; a succession of high rolling mounds interpose between them and the river, sometimes receding and allowing a small strip of fertile country to interpose and sometimes coming right down to the river bank.

The road winds along the foot of these mounds and a good view of the hills is difficult.

He was not able to say if this undulating country extended up to the hills; but, judging from the country near Khelát, which he explored more thoroughly, he would say it did not, but that between it and the real hills there were valleys and villages.

At Khelát-i-Ghilzái Captain Rogers fixed points to help in the survey of the country around. Colonel Sankey, Chief Engineer, employed some of his officers on a large-scale survey round the Fort, and Lieut. Ollivier, R. E. and Captain Sartorius of H. M.'s 59th Regt. were told off to work in connection with Captain Rogers further out. Owing to military reasons Captain Rogers was not able to go far, and did not cross the river to any distance until a few days before the Force left, when he got on a high hill south of Khelát and had a view towards the Arghasán Valley, which does not seem to be at all the chaos of indiscriminate hills entered on the maps; in fact in one direction he could see an opening of considerable width down which he could not detect a single hill with a telescope. Thanks to the exertions of Captain Chapman, Assistant Quarter-Master General, they were able to considerably improve the geography of the country. Supplied with points by Captain Rogers, Captain Sartorius made a topographical sketch of the country around Khelát and towards Ghazni. A small force went down the Arghasán Valley with directions to survey as much as possible. This expedition did not, however, bring in much as it degenerated into a simple route survey without any information 200 yards from the line.

Captain Rogers got leave to go down the Arghandáb Valley with a small force. He had with him Lieut. Ollivier, R. E., and did a fair amount of survey, about 400 square miles up to Kandahár. He describes the country as one vast conglomeration of hills and mountains very difficult to work in. The Arghandáb River is a large rapid mountain stream running in many cases between perpendicular cliffs; it is impossible to follow its course for more than a few miles at a time, it has numerous side streams along which are strips of fertile ground and villages. The halts are at these and the marches are generally up or down these side valleys and then over the intervening ridge into the next valley. Nearer Kandahár the hills are less continuous and the ground more open. The Survey party got on fairly well with the people, who brought in supplies and got well paid for them, but was unable to move without a strong escort as the people were not to be trusted. Captain Rogers says that so far as he has gone the distances and the positions of places such as Kandahár and Khelát are very fairly accurate, but the hills and general ideas of the country are faulty and require correction. For instance the part round Khelát-i-Ghilzái is entirely wrong. The Arghasán and Arghandáb Valleys are almost a blank. On the whole he thinks the Arghandáb Survey will be a good addition to the knowledge of the country. The route survey he made from Quetta to Khelát-i-Ghilzái is seemingly a repetition but, possibly, an improvement.

After the return of the expedition to Kandahár from Khelát-i-Ghilzái, Captains Heaviside and Rogers, R. E. were employed along with other officers of the Survey in making a survey of the country 12 miles round Kandahár on the scale of 1 inch to the mile, and several officers from different corps were appointed Assistant Field Engineers to take up the detail survey with plane-table.

Captain Heaviside has given an interesting account of Kandahár: he says it lies in a valley about 35 miles long, east and west, by 7 miles broad. The country to the east is a flat stony plain; to the west and south-west an area of some 40 square miles is thickly populated with numerous villages and a net-work of mud walls, orchards, and irrigation channels with but few roads, and what there are, narrow, tortuous, and more or less flooded by field irrigation channels.

Of the hills those to the north and north-east, distant 5 or 6 miles, are lofty and precipitous, completely shutting out the country beyond: those to the east though lofty are far distant. To the south-east there is a low short range, distant about 8 miles, over which glimpses of the country towards the Khojak Pass are obtained. To the south and south-west the country is open and the desert is seen as an elevated plateau. On the west there are sharp-peaked narrow ranges a good deal broken up, distant 4 or 5 miles, which become even more isolated and broken to the north-

west, and it is here that there are passes into the Arghandáb Valley whence the water is brought in which irrigates the Kandahár Valley. The water of the Tarnak is not, so far as he had seen, used for irrigation as it runs at too low a level. The city is built for the most part of mud and of sun-dried bricks, so little masonry is there about it; but it is built solidly, with walls 4 or 5 feet thick, on a large scale, and in the dry climate the weather does not very seriously affect even mud.

The high massive walls of the city appear in excellent order from outside, and it is only when one comes inside and stands on the tower of the citadel that the dilapidations become striking, and one comes to the conclusion that, with the exception of one or two mosques and a mausoleum, Kandahár is at least very much out of repair. The citadel is a palace with all the accessories of court-yards and stables on a large scale, surrounded by a high massive wall and ramparts of its own. The buildings in the citadel in many cases are of three and four storeys: the walls very thick, the rooms low and small, connected by numerous dark low passages with curious deep recesses, probably for servants; most of the buildings have well-lighted underground rooms—prophetic of great heat.

The bazar contains many good things of a certain class, and is crowded all day. The inhabitants treated the troops outwardly as if they were used to them, neither glad to see them, nor displeased at their being there, and they were at least ready to sell them anything.

There are excellent cheap sheepskin coats and stockings, *chogas* of *pashmina* and of capital close felt, which appears to be a Kandahár *specialité:* old British uniforms of all kinds, but very little English cloth, Manchester or other. The copper-work in pots and pans, the iron agricultural implements, the earthen-ware drinking and eating vessels all exhibit more finish and more artistic feeling than those of the Hindus. The leather too is much better prepared than in India, though there is still the same weak sewing.

But the feature as compared with the bazars of Hindustán is the variety and quantity of the food exposed for sale: fried fish and *kabobs*, stewed fruit and curds; the Kandahár bread, an excellent light flat cake; carrots, spinach and watercresses; while the stalls for the sale of raisins, almonds, dried figs, apricots and such pomegranates as Captain Heaviside had never seen before, were as common as public-houses in London.

In April, a party of surveyors, consisting of Captain Rogers and Lieut. Hobday with Captain Sartorius, 59th Regt. and Lieut. Baynes, 60th Regt. Asst. Field Engineers, accompanied a column going for revenue into the country north of Kandahár between the Arghandáb River and the hills of the north side of the Khakrez Valley, and the survey of this and adjacent valleys was carried out as the movements of the troops allowed, the northernmost limit being Asub Kila, or Gandáb, about 36 miles from Kandahár.

About 500 square miles were plane-tabled by Lieut. Hobday and Captain Sartorius on the $\frac{1}{4}$ inch scale; a route survey carried on on the 1-inch scale by Lieut. Baynes, and a number of points fixed trigonometrically.

Lieut. Hobday says, that they found the people in the Khakrez Valley quiet and amenable enough. There was a fair sprinkling of villages and cultivation, and water plentiful. They came across a fair-sized plateau at an elevation of about 7,000 feet, with wild rhubarb, onions, and water-cresses in abundance. The elevation of the valley is much higher than that of Kandahár, and they consequently found it much cooler and got away from the flies. They also came across lead, iron, copper and crystalite.

At Girishk, Captain Beavan made a large-scale survey and completed a map of the position at Girishk and passage of the Helmand on the scale of 4 inches to the mile, including about 20 square miles of the Helmand Valley with the Fort and military position. He also determined the position of numerous hill peaks.

After his return to Kandahár he completed a survey of the new cantonment on the scale of 16 inches to the mile, and at the end of April was engaged in carrying on a general survey of the cultivated land adjoining the city of Kandahár on the scale of 4 inches to the mile.

When it was determined early in February to withdraw a part of the Force by the Thal Chotiáli route under the command of General Biddulph, Captains Heaviside and Holdich, R. E., were appointed to accompany the Force as Surveyors, Captain Heaviside taking charge of the triangulation, and Captain Holdich of the topography.

Before starting, Captain Heaviside proceeded to the Kadanai Valley, where he measured a base line and carried a triangulation across the valley to the Hadah Hills and thence fixed several points to the North, East and West.

Captain Heaviside remarks that the name Ghanti given to the range between the Khojak Pass and Kandahár should be erased. The name is unknown and has probably been confused with the Ghetai Hills. It is very difficult to obtain correct names in Afghánistán, but from the Kadanai Valley the highest hill of the range is called Hadah; it rises 2,500 feet above the valley and scarcely deserves the name of a mountain in this part of the country.

Captain Holdich joined Captain Heaviside in the Kadanai Valley on the 26th February, and notwithstanding the thickness of the atmosphere and inclemency of the weather was able to sketch in on the plane-table a fair portion of the valley. These two officers re-crossed the Khojak on the 6th of March by a capital road with easy gradients which had been recently

made, and Captain Heaviside was able to connect his Kadanai work with the Khojak points, but only by staying on the top for several hours waiting for breaks in the alternations of dust and showers below and snow above. From these points he carried a connection by triangulation across the Pishin Valley to Khushdil, but with great difficulty owing to the heaviness of the weather. Captain Holdich at the same time carried on his plane-tabling on the basis of two or three points fixed by Captain Rogers near Quetta, also on points obtained from independent bases, and occasionally from the traverse work with compass and perambulator, which was continued steadily through from camp to camp. From Balozai, two marches beyond Khushdil, he made a reconnaissance southwards with Col. Brown, R. E., to Gwal and Amadún, while Captain Heaviside accompanied General Biddulph on a reconnaissance to the head of the Zhob Valley.

Leaving Balozai on the 24th of March, the Thal Chotiáli Force marched nearly due east through Eusaf Katch to Spirargah. The route led chiefly up the bed of a main tributary of the Surkháb river over the Ushtárah Pass 8,000 feet high. The scenery about this pass was quite Alpine in character: the camp was pitched at the foot of a fine snow mountain, the hill sides were fairly clothed with a species of juniper, while the extraordinarily varied and brilliant colouring of the soil lent additional charm to the scene and was a pleasant change from the monotony of flat treeless valleys and bare rocky hills that characterised the country between Kandahár and Quetta. From Spirargah the Force marched over the Momangai Pass (8,500 feet) to Oboskoi, Chimján and Ningán where the Bori Valley was struck. From Ningán, the line taken lay north of the route through Thal and Chotiáli pursued by the 1st and 3rd columns, and the Bori Valley was followed and for a distance of 30 miles was found to be wide and open, well cultivated and more prosperous looking than anything they had seen since leaving Kandahár. This valley was quitted three marches beyond Ningán where the Anambár river passes through a gap in the range bounding the valley to the south. The Khru mountain which overhangs this gap was ascended in the hope that some points on the Sulimán range would be seen therefrom, but this expectation was disappointed. A connected triangulation had been carried on to this point, but triangulation had now to be dropped and the Survey carried on solely with the plane table, checked by traverses and Astronomical latitudes. Leaving the Anambár gap (3,800 feet) the Force, instead of following the Anambár river southwards to Chotiáli, marched to the south-east, crossing the Trikh Kurram Pass (4,200 feet) and thence into the Chamálang Valley in two long marches. From Chamálang the route led due south over the Hanukai Pass (4,400 feet) to Balladaka, and thence over the Han Pass to the Kaho Valley. Between Anambár and the Kaho Valley the country is

rugged and the valleys even uninhabited owing to disputes amongst the neighbouring tribes. Lugári Barkhán (3,500 feet) in the Kaho Valley, about 10 miles above Vitákri, was reached on the 8th of April, after a march of 190 miles in 16 days.

Captain Holdich sums up the results as 5000 square miles of ¼ inch mapping, 270 linear miles of traverse on the 1 inch scale, and several plans of sites &c. The mapping includes the heads of the Pishin and Kadanai Valleys and a good margin beyond the country actually mapped, of which the geography can be very closely conjectured, so that the south-east corner of Afghánistán may be said to be known. Captain Holdich also says that there is a more northerly route which he would have liked to have explored; the real high road, as he believes, to Kandahár, and even better and straighter than the Thal Chotiáli route, good as that was found. This route leads *viâ* the Zhob Valley and the Karwaddi Pass, of which at present only native information is available. A railway could be run without difficulty along the route followed by the Survey.

After the Thal Chotiáli Force returned to India, Captains Heaviside and Holdich remained a month at Fort Munro on the Sulimán Range and were enabled while there to connect two Trigonometrical points on the range with several points to the west along the route they had come by, thus leaving a gap in the triangulation of less than 30 miles.

On the 10th May Major Campbell and Lieut. Gore accompanied Captain Wylie, the Political Officer, from Alizai on a reconnaissance to the Toba Plateau on the north of the Pishin Valley. The first camp, Arsala ka Masjíd, 10½ miles from Alizai, is in a *nala* about half way up the pass; 9 miles further, on the top edge of the plateau, at an elevation of 8,000 feet, they camped at Mandan, which is the name of the district and stream, though there is no village. Two marches further on they reached Haji Khán ka Kila, the extreme north-east point of their route. The country passed through is at first undulating, running into hilly towards the north. Major Campbell remarks that the name of what is called "Toba Peak" on the map is 'Kand.' The expedition marched back through Kakar Toba into Achakzai Toba, going *viâ* Sábur, Drajandar, Kurak, Gwal (one of Captain Holdich's points) and Ghan Oba, where they left the hilly ground and entered the open plain country called 'Tobin,' which lies west of Toba and borders the Kadanai Valley. It is the more extensive plateau of the two, but water is scarce. Hence they went to Sina across the plain over the ridge of the Khojak Hills (north of Pass) and down the Bogra Pass into the plain of Kadanai. Lieut. Gore says the upper part of the Bogra Pass into Kadanai is very steep and bad for camels for about ¼ mile, after that it is a good road.

The expedition was to go a short way up the Kadanai Valley, then up another road into Tobin, returning to Pishin by the Arambi Valley, quite a different route to that they went by.

The results of the Survey with this Column up to the end of May may therefore be summed up as follows:

Route Surveys from the Bhundowali Post to near Lehri, and from Dadur to Girishk.

Survey of the Bolan Pass and neighbourhood.

Survey round Quetta.

Survey of the Pishin Valley and reconnaissance of the Shorawak valley.

Reconnaissance of the Arghandáb and Arghasán Valleys from Kandahár to Khelát-i-Ghilzái.

Survey round Khelát-i-Ghilzái.

Surveys round Kandahár.

Survey round Girishk.

Survey of the Khakrez Valley.

Reconnaissance of the Kadanai Valley and survey of the Thal Chotiáli Route.

Reconnaissance of the Toba plateau and neighbouring country.

Captain Heaviside has given the approximate latitudes, longitudes and heights of the following places on the Thal Chotiáli Route, based on Captain Rogers' values, *viz.* :—

	Lat.	Long.
Takatú, east peak highest, ...	30° 24′ 13″	67° 6′ 15″
Chiltan, southern peak, ...	30° 1′ 11″	66 48 42
Khojak, east point, ...	30 51 33	66 33 54
Kwája Amrán, ...	30 39 30	66 24 45

Height of Quetta 5,500 ft.

The heights are aneroidal, and the passes are probably made a little too high.

Major-General Biddulph's Route.

	Lat.	Long.	
Khushdil (Pishin Valley),......	30° 42′	67° 5′	Height 5,100 ft.
Suranari Pass, ...			7,000 „
Balozai, ...	30 38	67 18	6,300 „
Metrazai Pass, ...	30 45	67 30	7,100 „
Ushtárah Pass, ...	30 36	67 32	8,000 „
Momangai Pass,.................	30 34	67 42	8,500 „
Chimján, ...	30 34	67 57	7,200 „
Ningán (Bori Valley), ...	30 27	68 23	5,350 „
Anambár Gap, ...	30 21	69 2	3,800 „
Chamálang Valley,.............	30 9	69 26	3,800 „
Hanukai Pass, ...			4,400 „
Han Pass, ...			4,800 „
Nahar Kot (Lugári Barkhán),	29 46	69 27	3,500 „

Major Sandeman and General Nuttall's Route.	Chimján as above, ...	30° 16′	68° 17′	
	Smalan, ...			
	Sagawe, ...	30 17	68 20	Height 5,500 ft.
	Baghao, ...	30 16	68 29	4,800 ,,
	Rehi, ...	30 9	68 35	3,900 ,,
	Tal, ...	30 1	68 43	3,200 ,,
	Chotiáli, ...	30 2	68 54	3,300 ,,
	Baramzai, ...	29 59	69 14	3,750 ,,
	Nahar Kot, as above.			

Balozai and Metrazai are in the Surkháb; the latter place being on the watershed at the head of the Surkháb and Zhob Valleys.

Since the above values were determined, Mr. W. C. Price has carried a triangulation from the Indus Valley Series across the Sind desert and up to Quetta. This connexion will enable the fair maps of Southern Afghánistán to be compiled on a base as rigorously accurate as other portions of the Survey of India.

II. Kuram Valley Column.

The Kuram Valley Force, under Major-General Roberts, c. b., v. c., being smaller than the others, the Survey operations have also been on a less extensive scale than those with the other two columns and have been confined almost entirely to the Khost, Kuram and Hariáb Valleys. From November 1878 to March 1879 Capt. Woodthorpe, r. e., was the only officer of the Survey of India present with the Column, but Lieut. Manners Smith, Adjt. of the 3rd Sikhs, was attached to the Survey party in November to accompany and assist Capt. Woodthorpe, and in March Lieut. Gerald Martin, of the Survey of India, also joined the party.

Capt. Woodthorpe had the great advantage of being in close and direct communication with Genl. Roberts and of accompanying him on all expeditions and reconnaissances, and thus had every opportunity for seeing and surveying as much of the country as was practicable under the circumstances.

Capt. Woodthorpe accompanied the Force in the rapid advance in November 1878 from Thall to the Peiwar, partly along the right bank of the Kuram River, *viâ* Kapianga, Ahmed-i-Shamu, Esor, Hazár Pír, the Darwáza Pass and Kuram, plane-tabling along the route. He took part in the military operations of the 28th November and 2nd and 3rd December, and had a very narrow escape during the action on the 2nd.

He had gone forward with the advance when they reached the stockades on the Spin Gawai at dawn; and when all the enemy had been driven out he returned with a message from Colonel Brownlow of the 72nd to the

General, who asked him to take back a reply. He was returning by the route he had just traversed, quite alone, and had left the breastwork where the rest of the 72nd were sheltering about 48 yards in rear, when he saw some 30 men occupying the crest within a few yards of him, and in the grey light he mistook them from their dress for some of the men of the Force going up in support of the advance, and, on the other hand, the enemy did not recognise him till he was within 6 yards of them and then fired upon him. A bullet struck him on the left side, completely carrying away the whole of the wood of his pistol stock, tearing his clothes, singeing his side and driving a piece of his clothes into the middle of the note-book in his breast pocket and spoiling several sketches.

He fortunately succeeded in regaining the breastwork amidst a storm of bullets, notwithstanding that he tripped and fell heavily down-hill about half-way.

After the battle he made a reconnaissance of the scene of action. He then went on with the Force into the Hariáb Valley, marching and plane-tabling through Ali Kheyl and Rokián, and was able to well delineate all the valley and as far as Rokián. From Rokián he was only able to carry on a route survey to the Shuturgardan, the valley being too narrow to admit of plane-tabling, and visits to places on either side were impossible. He was able to fix the Shuturgardan with sufficient accuracy and found it to be a good deal south-east of the position assigned to it on sheet No. 4 of the Atlas of India. The river a few miles above Rokián runs north-east from the Surkai Kotal instead of rather south-east, as in the map. Capt. Woodthorpe says that the old map is exceedingly accurate as far as the Peiwar, on the north bank of the river, but he has been able to improve it a little. On returning to Ali Kheyl, he visited the Matungeh Hill, a peak about 4½ miles north of Ali Kheyl, about 12,900 feet above the sea, Ali Kheyl being 7,300. From Ali Kheyl he returned with the Force, marching and plane-tabling through Chapri and Karaia in the Mangal country, to Kuram. On passing through the Mangior defile between Chapri and Kuraia on the 13th December, the baggage and rear-guard were attacked by Mangals.

Shortly after the return of the Force to Kuram, Capt. Woodthorpe and Lieut. Smith visited the Safed Koh, riding out from Kuram to some villages called Zerán, where they picked up a Turi guard, having also some Gúrkhas with them, and also had to change their mules for coolies, as they were told the mules could not go very far. They had, however, to take on the mules belonging to the Guard, as sufficient coolies were not procurable, and these mules got up within 2000 feet of the pass and would have gone right up, but there was no camping-place further on till the ridge was crossed and the road had descended again some distance towards the

plains. The route they followed was the regular Jelálábád road up which the Turi mules always go. They met a large number of unarmed traders coming in from Jelálábád. They reached a point about 13,600 or 14,000 feet high, but could not reach the highest point—Bodin Peak. The ridge was very steep and difficult and the path over snow-fields. From the point they reached they had a good view of the Fort at Kuram and all the peaks towards Khost. It was bitterly cold up there but they got angles to all the peaks they wanted.

Early in January the Survey party accompanied the expedition into the Khost valley, marching *viâ* Jaji Maidan, Bakk Akubi to Matún. From Matún Capt. Woodthorpe explored the valley to the west, in the direction of Degán, and also accompanied a signalling party to a hill on the water-shed between the Shamil and Tochi rivers, near the small Wazirí village of Nandir, and commanding an excellent view of the surrounding country. From this point heliographic communication was established with Bannu and Hazár Pír. On the 27th January the Force left Matún, marching back to the Kuram *viâ* Sabari, Esor, Hazár Pír and Ibráhímzai. During this expedition the greater part of the Khost valley was surveyed and mapped on the $\frac{1}{4}$ inch scale, the part wanting being at the extreme west.

After the return from Khost the survey party was engaged in making a route survey with plane-table and perambulator of the new road to Thall, *viâ* Ibráhímzai, Hazár Pír and Ahmed-i-Shamu; Capt. Woodthorpe also visited the Shobakgarh Range and fixed the position of the pass through that range to Khost.

About the middle of April the Survey party accompanied the Force to Ali Kheyl and remained there, surveying in the neighbourhood of the Peiwar, till the end of the month, the snow being about 18 in. deep on the hills at the time, and the weather very stormy and unfavourable for work.

Capt. Woodthorpe, accompanied by Lieut. Martin, paid a second visit to the Matungeh Hill, near Ali Kheyl, but they were disappointed in not being able to see and communicate with Gandamak, for which purpose signallers had accompanied them. They had a fine view, seeing far away into the plains near Ghazni and also to the Shuturgardan Kotal. The last 1500 feet of the ascent was very trying, on account of the snow with which the hill was covered and a biting cold wind that was blowing at the time, but notwithstanding this they managed to get through a good deal of work before returning to camp in the evening.

At the end of April Capt. Woodthorpe and Lieut. Martin went from Ali Kheyl *viâ* Belút to make a reconnaissance of the Lakarai Pass at the request of General Roberts.

From Belút the road lay along the bed of the Lalidar or Naridar stream

for some seven or eight miles, passing between thickly-wooded spurs of the mountains. It then winds up the spurs towards the Kotal, among the pines and here begins to be somewhat steeper, until it arrives at a small saddle from which to the Lakarai itself the slopes are somewhat slighter. From a little below this saddle to the Kotal the snow was very deep, $2\frac{1}{2}$ to 3 feet. On the north side it was deeper still, and sometimes lies 7 to 8 feet thick. The height of the Kotal is about 10,600 feet.

They crossed the Kotal and continued some little distance down to where they could get a fairly good view of the river-bed and the villages below. The part of the road near the Kotal is called Mangal Tangi and the villages in the valley are Gabar Mangal. They are Taghan, Langar Kila, Sirkoti and Nazir Mahomed.

The nearest is Taghan, about five or six miles from the Kotal, and is a fairly large village. They were unable to go down to this village, partly because it was getting late and partly because the villages were unfriendly. They could see the tops of the Jizin and Jagdalak Hills and, as at Matungeh, some of Major Tanner's points, but the height of the Safed Koh on the right and the hilly nature of the country in front prevented their seeing Gandamak or Jagdalak. Lieut. Martin was also able to see the other side of the Safed Koh and so check, correct and add to the work he had done at Matungeh. The weather was very cold with a wind which almost made their fingers too numb to draw. Lieut. Martin gives a very graphic description of the beauty of the scenery, which he describes as quite Alpine.

During the month of May reconnaissances were made to the Sirkai and Shuturgardan Kotals; to the Zarrazod Peak, near the Mangior Pass; to the Istiar Pass and head of the Mangior defile, looking over the Ahmed Kheyl country; to the Kafirtaga Hill and to the Naktek Peak, over the Ahmed Kheyl and Lajji country, on which occasion a good deal of work was done and the positions of the Ahmed Kheyl and Lajji villages fixed, and a good deal of the topography between Ali Kheyl and the principal part of the Kuram sketched in as well as the ranges and principal water-courses on the opposite side.

Lieut. Martin gives some interesting details regarding the course of the Kuram river. There are two principal sources. One rises near the Shuturgardan, flows east and then south; the other rises in the Peiwar range, flows west and meets the former at Ali Kheyl and continues along with it in that direction until it arrives at the Ahmed Kheyl *great* village. Here the bed narrows and the closeness of the rocks gives it the name of "Tangi." This is the spot where the river suddenly turns south into a

mountainous land ; and here the Ahmed Kheyls have a fort and stop and rob travellers to Ghazni or those going by the Spiga Kotal to Kábul, and on this account (so he was informed) this road, though the best and shortest to Ghazni, is generally avoided. The Umar and other hill streams here join and all flow together through a very mountainous rugged country. This part of the Kuram then turns sharply eastwards and flows on towards Kuram itself. In this portion of its course myriads of mountain streams and torrents feed it and thus it increases in size rapidly. From the joining of the Ali Kheyl and Umar until it comes into the Kuram Valley its course is through a very mountainous country inhabited by various robber tribes, Mangal, Ahmed Kheyl and Lajji.

On the 20th June Capt. Woodthorpe and Lieut. Martin, accompanied by other officers of the force and a party of signallers, ascended the Sikarám Peak (15,600 feet) on the Safed Koh, which had been already ascended by Mr. G. B. Scott, of the Survey, attached to the Pesháwar Column. Unfortunately the day was hazy and they were unable to see or do so much as they had expected.

The area surveyed by this party may be roughly estimated at 4,500 square miles and has been mapped and published on the scale of 4 miles to an inch.

III. Pesháwar Column.

The Survey operations with the Pesháwar Column, though not extending over such a length of country as those with the Quetta Column, have, perhaps, been more productive in new work, owing to circumstances having permitted a more complete survey of the country on either side of the route traversed by the Force than could be accomplished with the Quetta Column.

Five officers of the Survey Department—Major H. C. B. Tanner, B. S. C., Capt. E. W. Samuells, B. S. C., Capt. E. P. Leach, R. E., Capt. C. Strahan, R. E. and Mr. G. B. Scott, were employed from time to time during the occupation of the country by the British troops.

Of the operations connected with the earlier part of the campaign, the information furnished by the Survey Officers is unfortunately scanty. The results, however, speak for themselves.

Major Tanner completed a Military reconnaissance of the country between Jamrúd and Jelálábád on the scale of 1 mile to the inch. Nearly the whole of the portion between Jamrúd and Dakka, including the routes taken by the three brigades, was surveyed on the 2-inch scale by Mr. Scott, and afterwards reduced to the 1-inch scale in Major Tanner's office.

Major Tanner also made a reconnaissance on the scale of 1 inch to the mile of the hills lying to the immediate south of Dakka.

Capt. Samuells greatly distinguished himself at the taking of Ali Masjid by carrying on his survey under a heavy fire. Very shortly afterwards he was attacked with typhoid fever and died at Peshâwar on the 21st December, 1878.

Between the 1st November and 5th February, Mr. Scott had nearly completed a plane-table survey of 320 square miles-lying between Lat. 33° 55′ and 34° 15′, Long. 71° and 71° 30′, comprising most of the country south of the Kábul river between Dakka and Fort Michni to the north, and in the neighbourhood of the Khyber and Bázár Valley to the south.

He was then called on by Major Hastings, the Deputy Commissioner of Pesháwar, to survey the portions of the Shinilo and Hyder Khán Kafilah routes to Dakka which he had not been able to complete before, and also to survey certain additional portions of the Kábul River. Whilst engaged on this work he and his party, which consisted of a few *kalashis* and a guard of 20 Sepoys and 2 non-commissioned officers of the 24th Panjáb, N. I., were attacked by a strong party of Momunds and a hand-to-hand fight ensued. Mr. Scott displayed great gallantry, coolness and good judgment on the occasion, and probably saved the whole party from destruction, as has been cordially acknowledged by the Panjáb Government and by His Excellency the Viceroy and Governor-General in Council.

Capt. E. P. Leach, R. E., joined the Force in January and did good service for about two months in surveying the Bázár Valley and a good deal of the country round Jelálábád, chiefly in the Shinwári country on the northern slopes of the Safed Koh. He was attacked on the 17th March by some Shinwáris, while surveying near the villages of Maidanak and Girdi, and received a severe wound on the arm, which obliged him to return to Pesháwar.

Capt. Chas. Strahan, R. E., replaced Capt. Leach in April and was employed in surveying the country in the neighbourhood of Safed Sang and to the north of the road between that place and Jelálábád.

On the occasion of the first expedition into the Bázár Valley by the Column under General Maude on the 20th and 21st December, Mr. Scott accompanied the Force and surveyed along the route. During the second expedition of the 24th January and subsequent days he again accompanied General Maude's Column *viâ* Burg to China and completed a survey of the eastern part of the Bázár Valley and the scene of action towards Bara, while Capt. Leach, who accompanied General Tytler's Force from Basáwal *viâ* Chunar and Sisobi to China, returning from China to Dakka over the

Sisobi Pass *viâ* Chunar, did a good deal of survey in the western part of the valley, and was able to fill in a considerable portion of the hill tract between Dakka and the Sisobi Pass, the position of which was accurately fixed.

While the Force remained in the valley no surveying beyond the immediate vicinity of the camp at China could be undertaken, nor any exploration made towards the Bara and Tirab Valleys, the Zakha Kheyls at once opposing the advance of any reconnoitring parties in those directions.

Capt. Leach remarks, as the result of observations on this expedition, that the passes over the Safed Koh apparently exist at intervals of 5 to 10 miles, and the one they crossed—the Sisobi—was under 5000 feet and a comparatively easy one for camels.

The higher ranges of the Safed Koh are fairly wooded, but the Kábul river runs through a bare stony plain from Jelálábád to the Khyber, and cultivation is very limited.

The most notable feature of the country is the elevated valleys which are composed entirely of beds of conglomerate brought down from the main ranges, and which rise gradually several thousand feet before the steeper slopes like those of the Himalaya commence. It is difficult to explain the formation, but it presents all the appearance of a sudden disintegration of the mountain ranges by volcanic action, the drainage lines cutting out broad channels in the most erratic manner over the deposit thus formed, and the spurs apparently having been half-buried by the immense masses of loose stone.

The route between Dakka and Jelálábád was surveyed by Major Tanner, the survey comprising nearly all the country between the road and the Kábul river and the villages 2 or 3 miles to the north of the river, and it was afterwards added to, chiefly towards the south, by expeditions from Jelálábád.

Capt. Leach, writing in January of the route between Dakka and Jelálábád, says that the country is disappointing and the fertile valley of Jelálábád, so far as he could see, was a myth. There are few trees and for several miles to the south of Jelálábád there are undulating ranges of low hills with broad expanses of waste land covered with stones. This is the character of the road the greater part of the way from Dakka, and the tract of country it passes through is to all appearances a continuous river-bed. Round Jelálábád itself there is a certain amount of irrigated cultivation, but the camp and roads were deep in dust and there is absolutely no vegetation on the hills.

Various attempts were made to explore the hitherto unknown tract of country lying along the northern slopes of the Safed Koh range to the

south of the Kábul river between Basáwal and Jelálábád. Regarding this tract Capt. Leach says the valley proper extends about 10 miles on the southern side of the Kábul river and is fairly level, then comes a belt of low broken hills inhabited by the Shinwáris and then the main spurs of the Safed Koh Range which, in many cases, run nearly parallel to the main range and not at right angles, as shewn in existing maps.

The first of these expeditions was made by Major Tanner and Capt. Leach to the Shinwári village of Mazína, 14 miles south of Jelálábád, with a view to proceeding as far as possible towards the slopes of the Safed Koh and surveying the entrances to the Papin and Ajam passes; but as the Khán of Mazína refused to be responsible for any further advance into Shinwári country, the expedition had to be abandoned. Major Tanner was, however, able to fill in the drainage and low hills between Háda and Mazína, and he remarks that the country between Háda and the Mazína upland is intersected by numerous watercourses all paved with round boulders. The plain and broken ground between them is also thickly strewn with shingle and boulders, but after ascending a slight pass to the east of Za Khel, they suddenly found themselves in a beautiful plain highly cultivated and with forts and clumps of trees on all sides. The Safed Koh were but 10 miles off, with the valleys and slopes covered with beautiful pine forests. Between them and the foot of the mountains intervened more shelving stony ground with undulations that hid the cultivated lands of Deh Bala (the high village) from them. The cultivated lands stretch from Mazína northwards to Sher Sháh and almost reach the arid tract near the Chorazali road. Mazína is some 1200 feet above Jelálábád.

Early in March Capt. Leach received permission to survey over the old route between the Safed Koh and the Kábul river, followed by Burnes in 1839, confining his operations to the country eastward of Mazína. His first halting-place was at the Fort of a friendly Khán, 13 miles south of Jelálábád, and he had intended marching to Marhaiz, 9 miles further south and within 4 or 5 miles of the foot of the Safed Koh proper, whence he would have been able to get up to the lower spurs and snow-line, Marhaiz itself being 4000 feet; but as the Khán who escorted Capt. Leach said they would be certain to be attacked if they camped at Marhaiz, he changed his plan and went to his old camp at Mazína, where he had another day's work in the same direction and managed to get near enough to fix all the Shinwári villages at the foot of that particular part of the main range.

Capt. Leach says the country is a difficult one to sketch without actual survey.

The main range is easy enough and its features tolerably regular, but the lower slopes are completely buried by a glacis of low broken masses of

conglomerate and sandstone, so that the gorges to the passes and all the defiles are invisible till one is close to them, and nearly all the villages are quite out of sight. These lower ranges are generally detached and the valleys, or *daras*, are several hundred feet below them. He followed one of these *daras* down to its junction with the Kábul. For mile after mile they passed through a continuous belt of cultivation, thickly studded at every quarter of a mile with tidy-looking forts and showing every sign of comfort and prosperity.

Ascending either bank of the stream one passed at once from fertility to absolute barrenness, and a few miles away from the *dara* it was almost impossible to make out its course or to trace its windings through the hills to the foot of the range.

On the 17th March Capt. Leach was surveying the slopes of the Safed Koh in the neighbourhood of the Shinwári villages of Maidanak and Girdi, from 16 to 20 miles south of Barikhab, when he was attacked by the villagers and after a hard fight succeeded in withdrawing his party and the military escort. In the course of the fight Capt. Leach was severely wounded by a sword-cut in the left arm, Lieut. F. M. Barclay, who was in command of the escort of 45th Sikhs, received a wound which proved mortal, and two men were killed.

A few days afterwards an expedition under General Tytler was sent from Barikháb against the Shinwáris who had attacked Capt. Leach, Major Tanner and Mr. Scott accompanying the expedition as Surveyors. Major Tanner visited the scene of the encounter and was able at a height of 4,300 feet to see many points north and west of Jelálábád that he had never before seen, especially the Hindu Kúsh near Bamian, and the same range north of his position. He finds that Fardjgan is not at the foot of the Hindu Kúsh, but at the foot of one of its spurs.

Mr. Scott also accompanied General Tytler to the attack on Deh Sarak, and on this expedition and that to Maidanak made a reconnaissance of about 120 miles of Shinwári country and the neighbouring slopes of the Safed Koh.

The long halt of the Army at Jelálábád enabled the Survey Officers to make the most of such opportunities as they had for completing the survey of the almost unknown country around, but as a rule they were unable to proceed further out than the limit of a day's ride out and in, and this prevented them from extending their explorations so far as they would have been able to do under more favourable conditions.

During December and January the survey operations in the neighbourhood of Jelálábád were much hindered by a persistent opaque brown haze which entirely blocked the view beyond a few miles. Luckily Major Tanner was able to fix his position the very morning of his arrival, other-

wise he would not have been able to determine the true position for several weeks. And this was of the more importance because Major Tanner found that the position assigned to Jelálábád on existing maps was erroneous and that its true position is Lat. 34° 29′, Long. 70° 30′, instead of Lat. 34° 24′, Long. 70° 26′.

To the eastward, north of the Kábul river, Major Tanner accompanied an expedition through Kama into the hilly country beyond Girdao. Kama is described as a thickly-inhabited alluvial tract, intersected everywhere by canals and studded with many fortified villages and forts.

Major Tanner surveyed the course of the Kunár river for about 15 miles from its junction with the Kábul river, and filled in the country to the north of Jelálábád between the Kunár river and the Kábul and Lughmán rivers, known as the Dasht-i-Gamberi, a waterless alluvial sandy plain, together with the hills to the north of it, to a distance of 16 to 18 miles from Jelálábád.

Major Tanner was also able to make a rough sketch of the Kunár Valley, filling in the names from native information. The course of the Kábul river, westward from Jelálábád beyond the Daronta Pass, was laid down to a short distance beyond its junction with the Lughmán River, about 14 miles from Jelálábád, and Major Tanner found that this part of the country was very erroneously delineated on the old map, the course of the Kábul River being placed many miles too far north.

On the occasion of the expedition to Lughmán under General Jenkins, the Lughmán river was traced by Major Tanner and Capt. Leach as far as Trigarhi, 26 miles from Jelálábád, and a fair survey was made of the Lughmán Valley from the Daronta Pass to the junction of the Alishang and Alingár Rivers. A more extended sketch, based upon trigonometrical points, was also obtained of the surrounding hills and heads of the above river valleys and extending westward to the Bád Pukht and Tang-i-Shaidán Passes. Observations were taken from a point 4,200 ft. on the Panchpai Range. The forces met with no opposition, and Major Tanner says that the people came in crowds round his plane-table, curious to see the English. He found the Tajik or Kunár language prevalent.

Accompanying a column under General Macpherson, Major Tanner surveyed the country between Jelálábád and Bahram Khán's Fort, going *viá* the Tatang Pass, over the end of the Siah Koh Range, and returning along the foot of that range to Jelálábád *viá* the Lakki Pass.

Previous to the advance of the army Major Tanner surveyed and fixed the course of the Surkháb River as far as Sultánpur, with all villages and many forts, thus completing the survey one march on the road to Kábul with all the country to the north of it as far as the Siah Koh Range.

On a subsequent occasion Major Tanner went to Sultánpur and surveyed a strip of the country south of the road, meeting nothing but a waste of stony hills and deep ravines. Low hills to the south prevented his seeing the cultivated tract and villages under the Safed Koh. It had been intended that he should survey Burnes' old route between Fathiabád and Chapriar and also that he should, if possible, visit and report on the bridge over the Surkháb river near Gandamak and also visit the old British cantonment at Kája, but unfortunately heavy rain stopped the work and the party were obliged to return to Jelálábád.

On the advance of the army to Gandamak, in April, Major Tanner, Capt. Strahan and Mr. Scott accompanied the Force and surveyed the road to Gandamak and the country north and south of it between the Surkháb and the Safed Koh, Capt. Strahan taking the northern portion and Mr. Scott the southern.

In the reconnaissance to Gandamak Bridge (Safed Sang) Major Tanner found that the topography of the old map was very inaccurate. The general slope of the Surkháb is about 200 feet per mile and in one part the gradient of the plain which reaches to the foot of the Siah Koh was a great deal more, hence the unexpected bends and turns the streams make in a country covered with ridges and hillocks, where the southern edge has been upheaved in moderately late times.

Major Tanner also made a reconnaissance to the Wara Gali Pass, over the Siah Koh Range, extending as far as the watershed. The pass is easy but rocky. The slopes of the Siah Koh are craggy and have only sparse scrub for about half a mile. Unfortunately the weather at the time was bad and no observations could be made to peaks to the north.

Capt. Strahan's particular work was the survey of the country between Safed Sang and the Surkh Púl and he made a really fair survey (much more than a sketch or reconnaissance) of about 80 square miles north of the road up to the Surkháb and got a good general sketch of the Siah Koh beyond, up to the crest of the first range.

Capt. Strahan remarks that the name Safed Sang (white stone) had not been written against the camp so-called, because there is no village of that name, which refers to some big white stone in the river there. The nearest village is Hashim Kheyl. He also remarks that the weather at Safed Sang at the end of April was very changeable, one day high wind with dust, then cold wind with rain or hail, then a hot sultry day, the latter being the rarest and the other two about equal. The thermometer rose from 85° to 95° maximum, and was about 58° minimum.

The valley at Safed Sang is of no great width, and all the low ground within easy reach of camp was mapped by Capt. Strahan with very fair

accuracy and detail. From four stations round about he was able to fix almost every prominent point in the Safed Koh and Siah Koh and also in the Karkacha range some 25 miles to the west.

As soon as he heard that the troops were likely to return to India, Capt. Strahan sent Mr. Scott to the Safed Koh with instructions to get in all the sources of the Surkháb as far as possible, and to fill in all up to that river south of the road which will form the limit of the Survey. He himself started for the Siah Koh and did two days' good work from two peaks from which he had a most extended view. From the first he could see beyond Kábul and the Hindu Kúsh, somewhere near the Khevak Pass, but the high peaks there and about Kohistán and Panjshir were cloudy. From the second peak he could not see in the Kábul direction, but picked up some peaks on the Hindu Kúsh and got second rays to two peaks in Káfiristán, somewhere about the sources of the Alishang and Alingár rivers. He intended to have visited a third peak but was ordered to go with Capt. Stewart of the Guides, to Ali Kheyl by the Lakarai Pass over the Safed Koh. This attempt unfortunately failed.

Mr. Scott got to the top of the Sikarám Peak, on the Safed Koh (15,622 feet), and did a great deal of good work, observing to one solitary peak in the Hindu Kúsh in a part of the range unseen by any of the surveyors before, as it was hidden by the Káfiristán hills.

The total area actually surveyed during the progress of the operations of the Pesháwar Column may be roughly estimated at about 2,500 square miles, a great part of which is quite new and the remainder correction of the old, incorrect and imperfect surveys. Besides the above 1,100 square miles were sketched from native information by Mr. G. B. Scott. It has all been mapped and published on the scale of 4 miles to an inch.

During his stay at Jelálábád, Major Tanner took the opportunity of studying many points of interest connected with the numerous antiquities in the vicinity and the languages of the people, chiefly of the Káfirs.

At Háda, about five miles south of Jelálábád, he came across a splendid subterraneous palace of the old Káfir kings, known as the Palace of Oda, Hoda or Hodé Rájá, and had it excavated, finding several beautiful plaster heads and fragments.

He made some study of the language spoken north of the Kábul river, through Kunár, Lughmán, Kohistán &c. He says it has a most perfect grammar and is an Aryan language, he thinks very old and pure, and allied to that of the Káfirs, which he finds to be also Aryan and not Turanian. He had the names of several tribes of Káfirs, *viz.* Sána, Wáma, Kantáwar, Bukiwáma, Muliarwáma, Shinogur, Kaliagal, Waigal and Nishigam. Each tribe is said to have a separate language.

In the course of one of his excursions up the Siah Koh he collected

specimens of five kinds of pines. Of these the Chilgoza (edible pine) grows at from 7000 to 9000 feet; the Deodar from 7,500 to 10,500; the Paloda from about 9,000 to 12,500. A pine with small berries like an *arbor vitæ* grows above the deodars.

Major Tanner had all along been most anxious to avail himself of the rare opportunity which offered for exploring the interesting and almost unknown country of Káfiristán, and after a great many difficulties was able to make a start in that direction with the aid of the Chúganí Chief, Azím Khán, with whom he had an interview at Jelálábád through the instrumentality of Mir Ahmed Khán, of Shewa in Kunár, and Shaik Hussain Khán, also of Kunár. He describes Azím Khán as a handsome, pleasant looking man, of ruddy countenance, rather short, but as strong as Hercules. His followers also had soft pleasant faces. The chief presented him with honey, horns and cheese, and Major Tanner gave him presents of *lungis*, sweetmeats *&c.* in return; after receiving these the chief held out his hand and protested a lifelong friendship, declaring that his country and towns were open to Major Tanner at all times. He promised to take him all over Kohistán and to the gates of Káfiristán.

Notwithstanding the very disturbed state of the country north of the Kábul river, and its being in a state of anarchy, in which every man's hand was against his neighbour, Major Tanner started from Jelálábád on the evening of the 15th May, disguised as a Kábuli, with six of Ahmed Khán's men and two of his own. After a little difficulty at the ferry over the Kábul river, they crossed the plain of Besud and entered the Paikoh Tangi Pass. They walked quickly through the beautiful plain of the Kunár Valley and reached Ahmed Khán's Fort at Shewa, where he was well received by the owner. Hardly had they entered the Fort, which is really a walled village containing not only Ahmed Khán's houses but those of his retainers and friends as well, than there was a great disturbance and firing of shots caused by the discovery of people coming down on the ripening crops, but they were beaten off. The next day passed quietly. Major Tanner had arranged with the Chúganí Chief Azím Khán to meet him at Shewa and the chief had been with Ahmed Khán some days, but deferred starting owing to the disturbed state of the country. On the next morning, at dawn, a large party of Ahmed Khán's enemies, hearing of Major Tanner's arrival and of that of their enemy Azím Khán, attempted to surprise the Fort, but Mir Ahmed Khán having been informed beforehand of their intentions had taken precautions and they were driven off with the loss of three men.

Major Tanner took advantage of the defeat of these hostile clans to make a start before they could collect again and, all arrangements being

complete, he set off in the evening with five Chúganís, three of his own men and Azím Khán. The greater part of the road led along the bank of the Kunár river, which they left at Islámpur, and then commenced the ascent of the sloping terraces near the hills.

When near Budiali, being apprehensive of meeting enemies of Azím Khán and Ahmed Khán, as they had been all along the route, they made straight up the face of the hill near that town. These hills are absolutely dead and barren, but at about 800 feet they found tufts of grass and at 1000 feet a scrubby bush. In the morning they went down to the bottom of the range they had been climbing all night and then ascended another ridge, the hills changing in appearance as they climbed; at first a bush or a tree, then a wild olive, and, after going up some 1,500 feet, some green grass and a bush that bore some pleasant-tasting edible berries. The crest of this ridge was nearly 1,800 feet from the base and after proceeding along it for about an hour they reached one of Azím Khán's hamlets and rested there. The hills around were steep and craggy and supported stunted oak, wild olive &c., and at the rude huts there were clusters of date trees.

Major Tanner remarks that these are the only date trees he has seen so high as 4,500 feet, except those which grow at some places on the highest crags of the Western Ghauts; but while on the Ghaut the fruit ripens about May, these trees showed no signs of buds even in that month.

Starting again, they followed the valley which rapidly ascended till they made the crest at 5,300 feet, and there they looked down on to Shúlút, about 1000 feet below them, and near the upper end of a narrow but highly cultivated valley. Shúlút was reached at sunset, and Azím Khán advised Major Tanner to pass himself off as a Khán from Kábul travelling to see the country, for the village was inhabited partly by his men and partly by another tribe. His Kábuli disguise had been hateful to him all along, but he was glad of it now because the people in a friendly sort of way came and sat down and moved about among the party at their pleasure. He was given food, a *chupatti* and a piece of cheese, but was too much fatigued to eat much. After a good sleep they went off early in the morning and ascended the pleasant valley of Shúlút. Oaks and olives clothed the sides of the hills and carefully-terraced fields were ranged along the sides of the streams. The notes of parrots, blackbirds and cuckoos were heard and little birds twittered in the branches. They crested the head of the valley at 7,300 feet and a noble view was before them. On one side Kúnd and its pine-clad spurs and white rounded snow crests, and on the other the Kunár valley, and beyond it the Bajour and Momund Hills. Below these were the terraces of Aret and just above them the chief town of that name, just clinging to the sides of a steep spur. Besides the chief town were smaller

ones in different parts of the valley. Every possible spot was terraced, and there did not seem room for another acre of cultivation in the neighbourhood.

They had a descent of over 2000 feet, and at 5,200 reached the beautiful mountain torrent that waters the cultivation. Crossing it by a wooden bridge, they passed under groves of walnuts and along the edge of delightful terraces of waving wheat. There was foaming and rushing water everywhere, and creepers and ferns grew in the crevices of the rocks, and on the flatter parts of the craggy spurs grew oaks and wild olive. Houses built partly of wood and partly of stone, with flat roofs and carved supporting posts and bearers, were situated here and there, sometimes in groups and sometimes singly on the most exposed positions. The chief Azím Khán conducted Major Tanner to a house some 200 feet above the stream and about half a mile from the chief town. Up the valley, looking past walnut groves, terraces and hamlets, he could just see the round snow peaks of Kúnd, rising out of the black pine forests that clothe the mountains from 7000 to about 11,000 feet. Below were groves, scattered houses and the roaring torrent fed by the snows of Kúnd. From all he could gather this collection of villages does not much differ from those of the Káfirs who build partly of wood and partly of stone.

Major Tanner says of the principal village that the houses are piled one above another, and every beam, doorway and shutter carved in a most elaborate manner. The designs are crude, it is true, but such a mass of carving he had never before seen anywhere.

In the principal town there are many hundred houses, and in the whole group he was told there were 1000, and this cannot be over the mark.

Major Tanner's arrival caused a disturbance on the part of the inhabitants which was only put down by the Chief's authority. He is all powerful and his word appears to be law.

In Aret, the largest Chúganí colony, there is no *baniya*, so that the people have to take their goods two days' journey before they can find a market.

Major Tanner found Chúganístán more extensive than he had been given to understand it was. What the number of the tribe may be Azím Khán could not say, but in the valley of Arẹt alone, there must be at least 5000 and they have many villages, or rather the heads of many valleys, the lower portions of which are inhabited chiefly by the Safis, the hereditary enemies of the Chúganís. The Safis are Afgháns and the Chúganís in Major Tanner's opinion are converted Káfirs. He liked the Chúganís; they are a quiet set, said to be faithful to their masters and true to their engagements. They are brave and well-disposed towards the English and,

Major Tanner thinks, would probably offer a good field for recruiting amongst a hardy race who have no sympathy with the Afgháns.

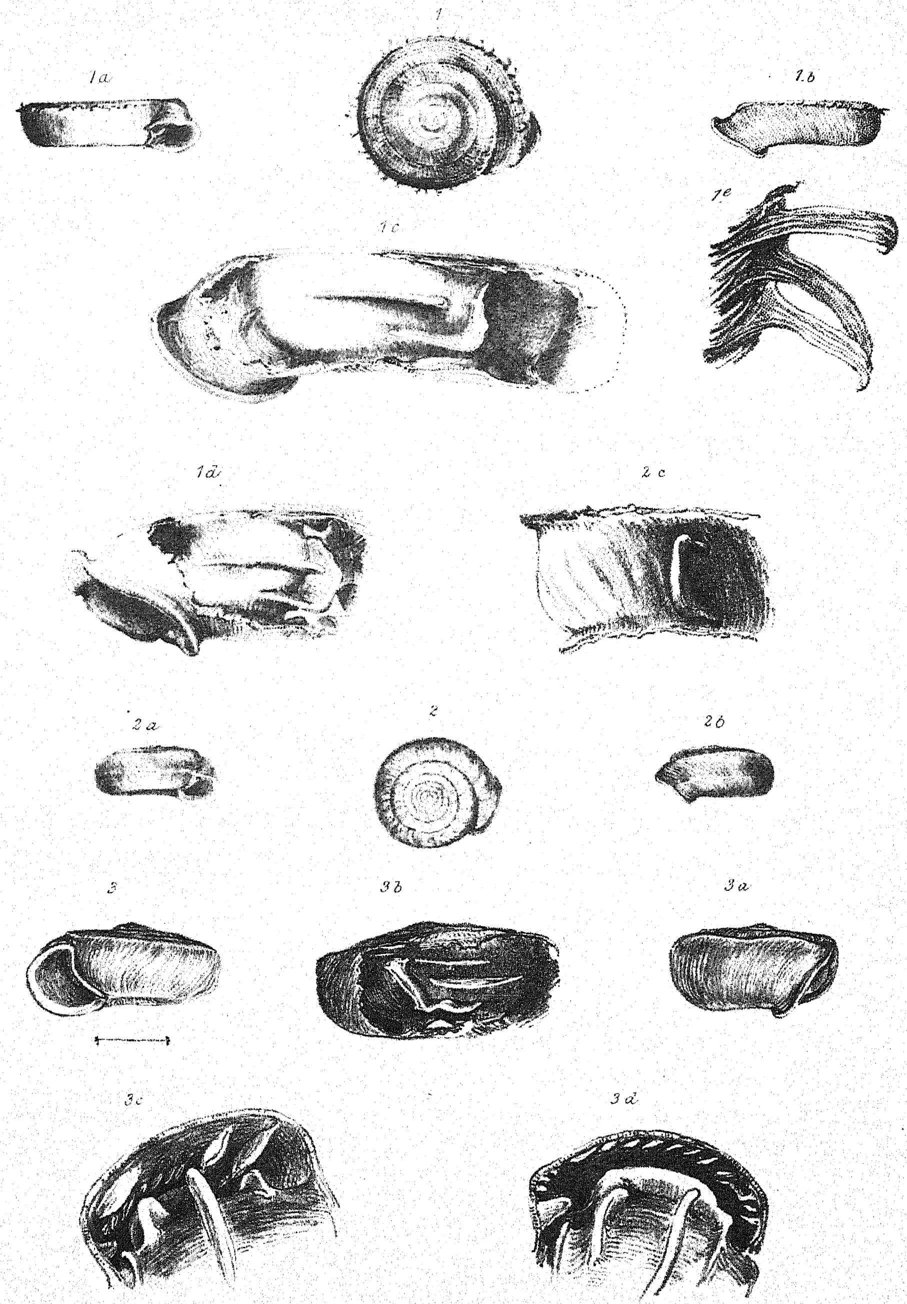
Major Tanner says that Azím Khán's wife and children moved about among them, and did their household duties without any shamefacedness. As they came up the valley, all the women greeted the Málik with a smile, and conversed without restraint. The young women have very handsome features, and some are very pretty but much disfigured by dirt.

A few days after Major Tanner's arrival in Aret, he had a bad attack of fever, which he got over and, though weak, made all arrangements for a final advance, when he had a second and very severe attack to which he nearly succumbed and which compelled him, most unfortunately, to abandon his design and return to Jelálábád.

After an appeal to Azím Khán's 'friendship', he was allowed to leave and was carried off between two poles to Jinjapur, about two days' journey By the kindness of the Jinjapur Málik he was safely conducted by the Málik's two sons and a large armed party, through a hostile country to the mouth of the Dar-i-nur, and eventually he reached Ahmed Khán's Fort at Shewa where he was safe, though the Fort was attacked immediately after his arrival by an armed party they had met on the road when going down the Dar-i-nur.

From Shewa he went down the Kunár river to Jelálábád on a raft.

The untoward failure of this expedition is much to be regretted as Major Tanner would undoubtedly have been able to throw much light upon this little known country had he been able to carry out his plans.

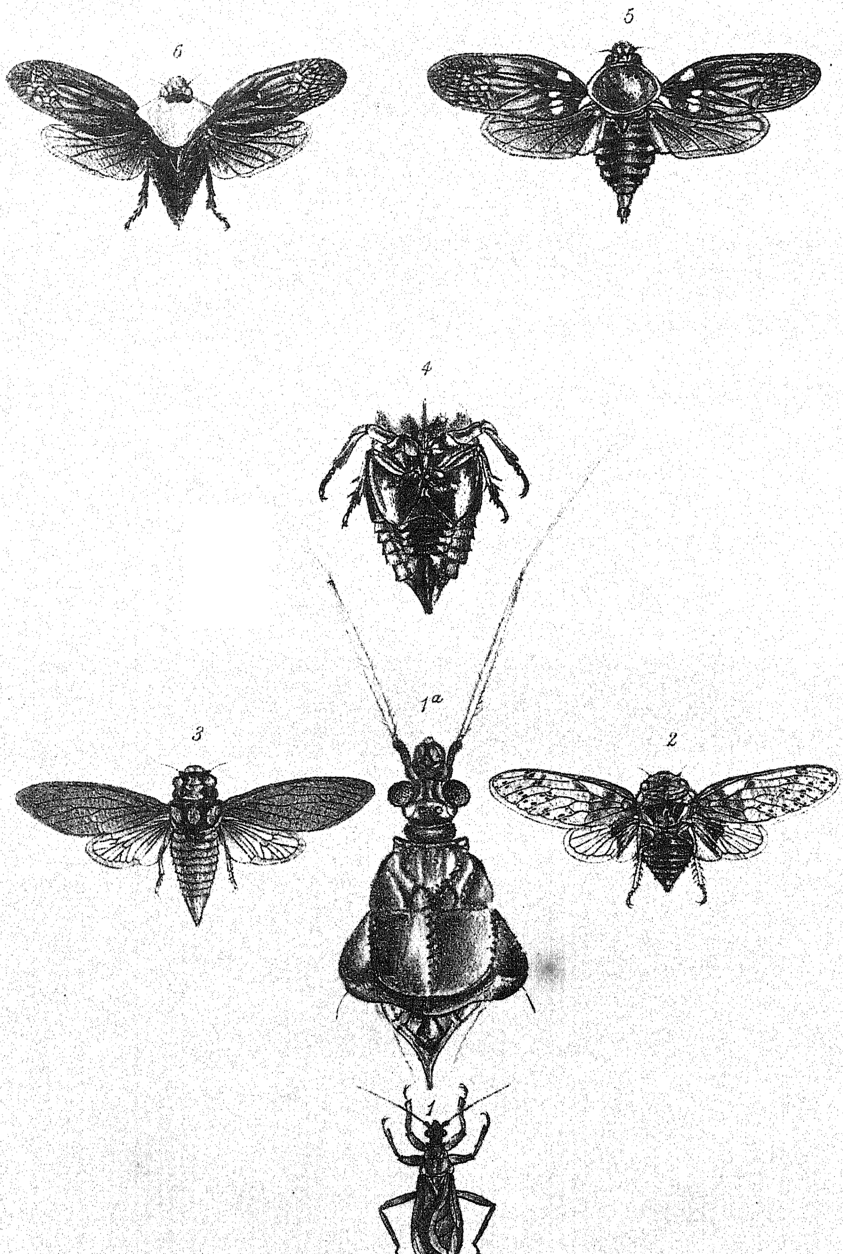


H.H. Godwin-Austen del et lith.

Maclure & Macdonald Im

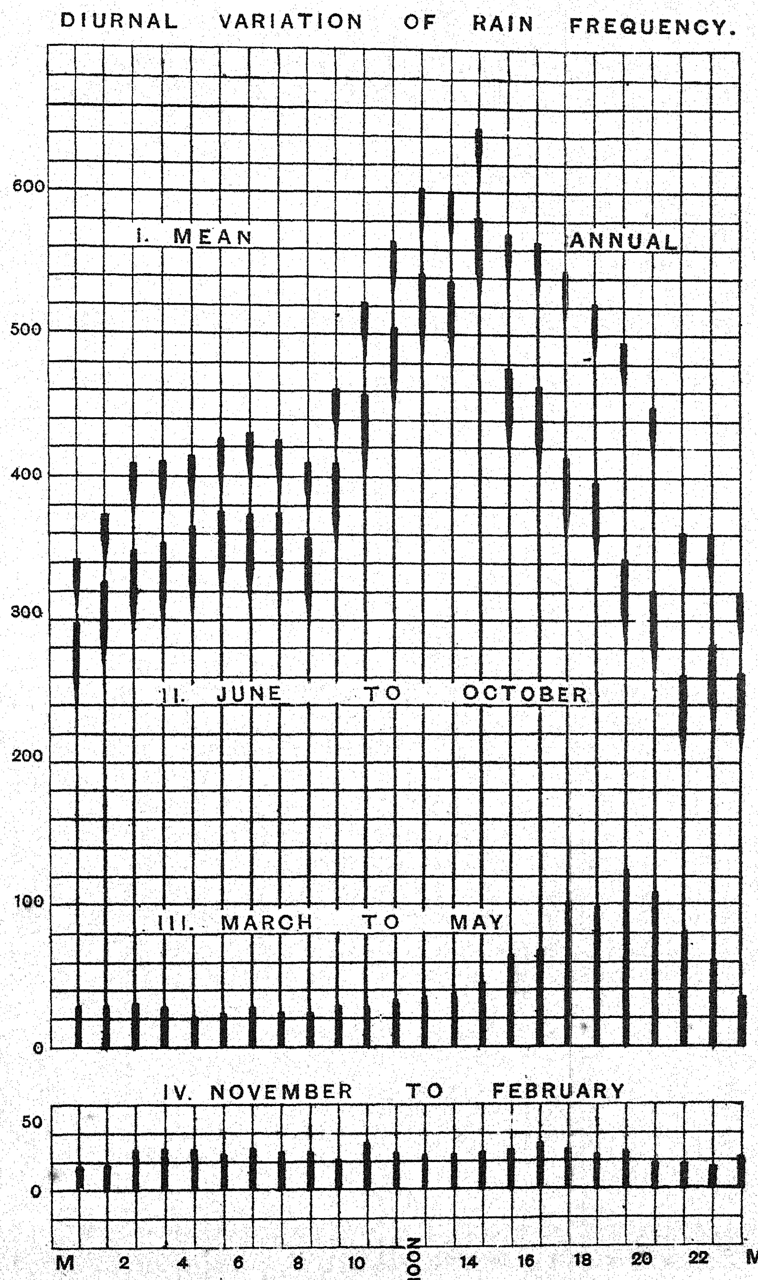
NEW SPECIES OF PLECTOPYLIS.

TENASSERIM AND ASSAM.



Robert H.F. Rippon, del. et lith. Hanhart imp.

TENASSERIM HEMIPTERA.


DIURNAL VARIATION OF RAIN FREQUENCY.
I. MEAN ANNUAL
II. JUNE TO OCTOBER
III. MARCH TO MAY
IV. NOVEMBER TO FEBRUARY
600
500
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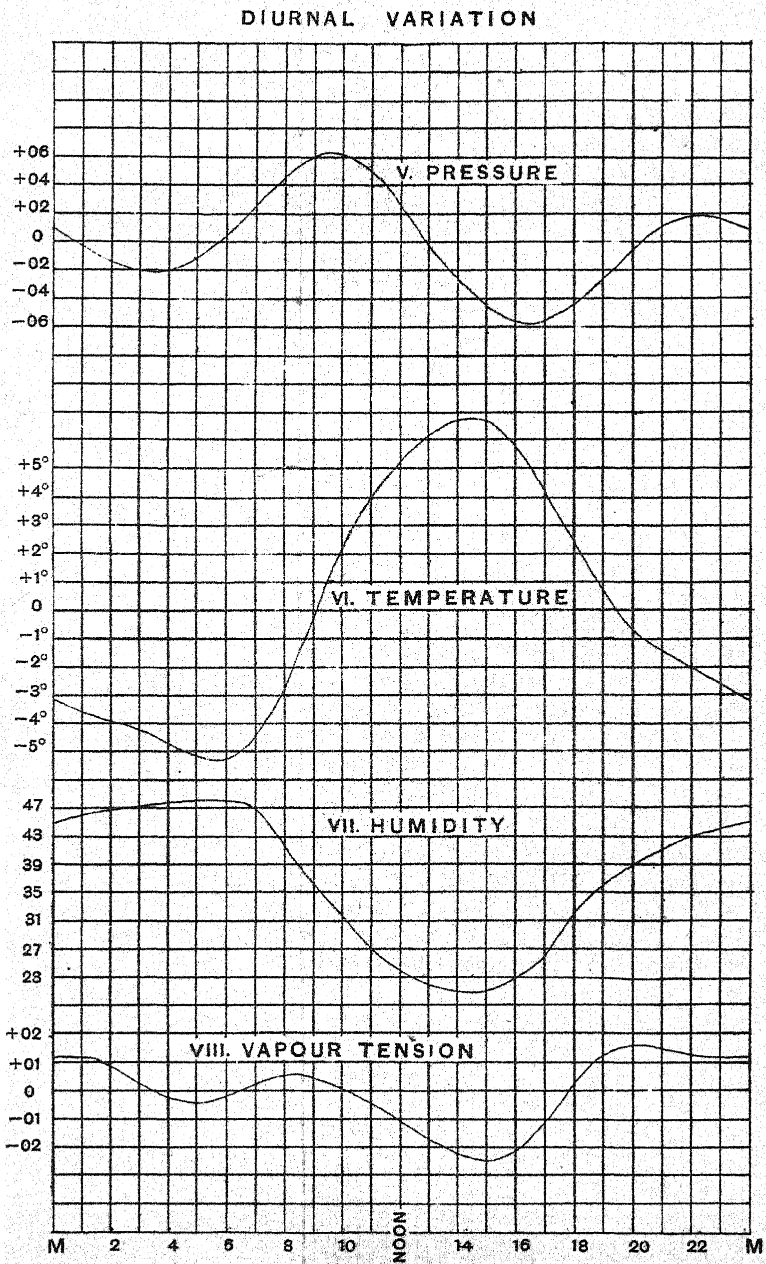
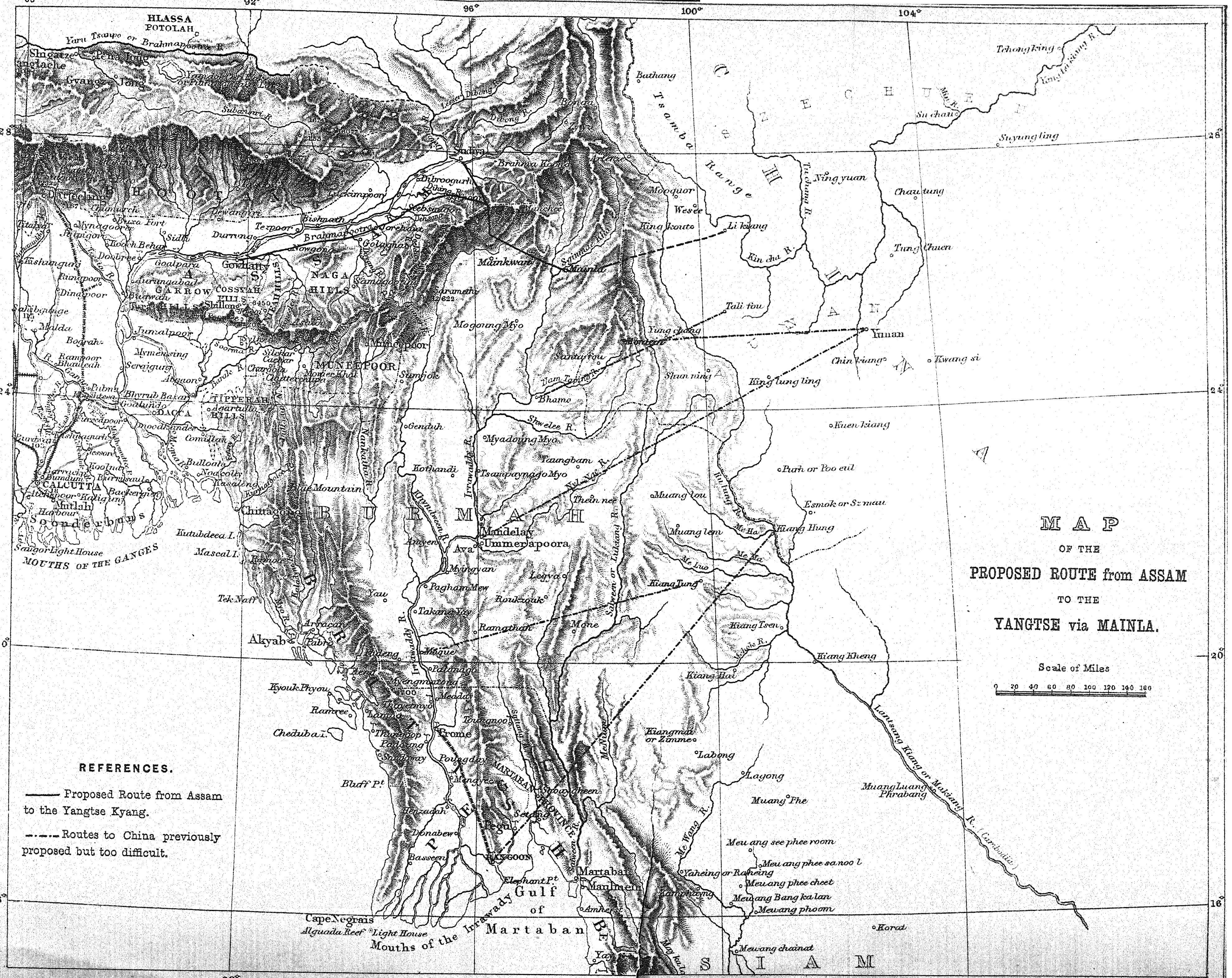


Photozincographed at the Surveyor General's Office Calcutta.



MAP
OF THE
PROPOSED ROUTE from ASSAM
TO THE
YANGTSE via MAINLA.

Scale of Miles

0 20 40 60 80 100 120 140 160

REFERENCES.

——— Proposed Route from Assam to the Yangtse Kyang.

-·-·-·- Routes to China previously proposed but too difficult.

INDEX.

☞ Names of new genera and new species have an asterisk (*) prefixed.